

100% Design

**Water Pollution Control Plan (WPCP)**

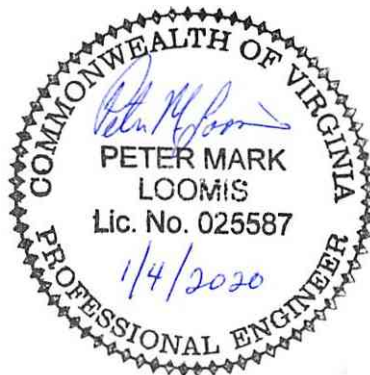
**Preliminary Treatment Upgrades  
(WPB2) Phase 9B**  
Arlington, VA

**Technical Specifications**

**Department of Environmental  
Services (DES)**

**Water Pollution Control Bureau**

January, 2021



**CDM  
Smith**



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## SECTION 011000 – SUMMARY

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work by Owner.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and Drawing conventions.

B. Related Requirements:

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

#### 1.2 PROJECT INFORMATION

A. Project Identification: Water Pollution Control Plant Preliminary Treatment Upgrades (WPB2) Phase 9B.

1. Project Location: 3139 S. Fern St., Arlington, VA 22202.

B. Owner: Arlington County Department of Environmental Services (DES),

Water Pollution Control Bureau

3402 S Glebe Road, Arlington, VA 22202

703-228-7954

1. Owner's Representative: Lisa Racey

C. Engineer: CDM Smith, 10560 Arrowhead Drive, Suite 500, Fairfax, VA 22030

#### 1.3 WORK COVERED BY CONTRACT DOCUMENTS

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

1. The Contractor will furnish all labor, materials, and equipment for the upgrades to the Preliminary Treatment Building (PTB) at the Arlington Water Pollution Control Plant

(WPCP). Upgrades will include replacement of three automatic bar screens, two shaftless screw conveyors, two washer/compactors, one scum concentration system, six effluent slide gates, three influent slide gate motor actuators, ventilation systems and odor control, improvements to the panel room, and all other work necessary to complete the work under this Contract include Demolition, HVAC, Electrical and Instrumentation and Controls and other Work indicated in the Contract Documents.

B. Type of Contract:

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

1.4 WORK BY OWNER

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

1.5 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Preceding Work: Owner has awarded separate contract(s) for the following construction operations at Project site. Those operations are scheduled to be substantially complete before Work under this Contract begins.
1. NMB/PTB Heating Water Piping Replacement
  2. PTB MCC-1A and MCC-1B Upgrade (WPBI) – Phase 9A.

1.6 FUTURE WORK

- A. The Contract Documents include requirements that will allow Owner to carry out future work following completion of this Project.

1.8 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
1. Limits: Confine construction operations to the PTB building and those staging areas defined on the Drawings.

2. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
  - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
  - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

#### 1.9 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and existing building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
  1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
  2. Notify Owner not less than two weeks in advance of activities that will affect Owner's operations. Activities shall be scheduled for Owner's convenience. This may include the Contractor performing night and/or weekend work.
- B. Work cannot interfere with continuous operations of the Owner's facility. The Owner can deny startup and shutdown requests for any reason.

#### 1.10 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
  1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7 a.m. to 7 p.m., Monday through Friday, unless otherwise indicated.
  1. Weekend Hours: 7:00 am to 7:00 pm
  2. Hours for Core Drilling, jack-hammer, or welding of any kind: : Timing must be coordinated and approved by Owner.

- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
  - 1. Notify Project Officer not less than two weeks in advance of proposed utility interruptions.
  - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
  - 1. Notify Owner and Engineer not less than 7 days in advance of proposed disruptive operations.
  - 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Restricted Substances: Use of tobacco products and other controlled substances within the existing building is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
  - 1. Maintain list of approved screened personnel with Owner's representative.

#### 1.11 SPECIFICATION AND DRAWING CONVENTIONS

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

3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 011000





## SECTION 012001 - PRICE AND PAYMENT

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Lump sum prices.

#### 1.2 LUMP SUM PRICES

- A. Payment of the lump sum price bid shall constitute full compensation for all labor, materials, tools, equipment and incidentals necessary for constructing the Preliminary Treatment Upgrades (WPB2) – Phase 9B complete, as shown and as specified in Divisions 01 through 46. Payment shall fully compensate the Contractor for all incidental work which is not specified or shown but which is evidently required to complete the work of this item.

#### 1.3 EXTRA WORK

- A. Extra work, if any, will be performed in accordance with Article III.G of the General Conditions and will be paid for in accordance with the provisions of Article III.G of the General Conditions.

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION (NOT USED)

END OF SECTION 012000



## SECTION 012500 - SUBSTITUTION PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor or Owner.
  - 1. Substitutions for Cause: Changes proposed by Contractor or Owner that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

#### 1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit each request for consideration electronically. 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: Electronically transmit an appropriate form or letter.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
    - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. Certificates and qualification data, where applicable or requested.
  - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Engineers and owners.
  - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
  - i. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - 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, except as indicated in substitution request, is compatible with related materials 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.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within ten days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or ten days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
  - b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

#### 1.4 QUALITY ASSURANCE

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

#### 1.5 PROCEDURES

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

## 1.6 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
1. Conditions: Owner will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - b. Substitution request is fully documented and properly submitted.
    - c. Requested substitution will not adversely affect Contractor's construction schedule.
    - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - e. Requested substitution is compatible with other portions of the Work.
    - f. Requested substitution has been coordinated with other portions of the Work.
    - g. Requested substitution provides specified warranty.
    - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Owner will consider requests for substitution if received within 60 days after the Notice of Award. Requests received after that time may be considered or rejected at discretion of Owner.
1. Conditions: Owner will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Owner will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    - b. Requested substitution does not require extensive revisions to the Contract Documents.
    - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - d. Substitution request is fully documented and properly submitted.
    - e. Requested substitution will not adversely affect Contractor's construction schedule.
    - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - g. Requested substitution is compatible with other portions of the Work.
    - h. Requested substitution has been coordinated with other portions of the Work.
    - i. Requested substitution provides specified warranty.
    - j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012500

## SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
  - 1. Section 007200 "General Conditions" for additional requirements for authorization, execution, written notification, costs and fees associated with Contract changes.
  - 2. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

#### 1.2 MINOR CHANGES IN THE WORK

- A. Owner will issue Field Orders authorizing minor changes in the Work, not involving adjustment to the Contract Price or the Contract Time, on form included in Project Manual.

#### 1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Owner will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Price or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Requests For Proposal (RFP) issued by Owner are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within 21 days after receipt of RFP, submit a quotation estimating adjustments to the Contract Price and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.
    - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
    - e. Quotation Form: Use forms acceptable to the Owner.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Owner.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Price and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to the Owner.

#### 1.4 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Change Order Request, Owner will issue a Change Order for signatures of Owner and Contractor on form included in Project Manual.

#### 1.5 WORK CHANGE DIRECTIVE

- A. Work Change Directive: Owner may issue a Work Change Directive on form included in Project Manual. Work Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
  1. Work Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Price or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.
  1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012600



## SECTION 012900 - PAYMENT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
  - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
  - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

#### 1.2 DEFINITIONS

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

#### 1.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
  - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
  - 2. Submit the schedule of values to Owner at earliest possible date, but no later than **ten** days before the date scheduled for submittal of initial Applications for Payment.
  - 3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
  - 1. Identification: Include the following Project identification on the schedule of values:
    - a. Project name and location.
    - b. Name of Owner.
    - c. Contractor's name and address.
    - d. Date of submittal.
  - 2. Arrange schedule of values consistent with format of EJCDC Document C-620.

3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
  - a. Related Specification Section or Division.
  - b. Description of the Work.
  - c. Name of subcontractor.
  - d. Name of manufacturer or fabricator.
  - e. Name of supplier.
  - f. Change Orders (numbers) that affect value.
  - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
    - 1) Labor.
    - 2) Materials.
    - 3) Equipment.
4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
5. The Schedule of Values shall be consistent with the items identified on the Bid Form pricing sheet, Appendix A.
6. Provide a separate line item categorized under each item identified on the Bid Form Pricing Sheet in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
7. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate Owner payments or deposits, if any, and balance to be paid by Contractor.
8. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
9. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
10. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling maximum five percent of the Contract Sum and subcontract amount.
11. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

#### 1.4 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Owner and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

- C. **Payment Application Times:** Submit Application for Payment to Owner by the 15th day of the following month. The period covered by each Application for Payment is one month, ending on the last day of the month.
1. Submit draft copy of Application for Payment seven days prior to due date for review by Owner.
- D. **Application for Payment Forms:** Use AIA Document G702 and AIA Document 703 as form for Applications for Payment.
- E. **Application Preparation:** Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Owner will return incomplete applications without action.
1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
  2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
  3. Include amounts of Change Orders and Construction Change Directives when the Purchase Order has been issued before last day of construction period covered by application.
  4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- F. **Stored Materials:** Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed.
1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment.
  2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
  3. Provide summary documentation for stored materials indicating the following:
    - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- G. **Transmittal:** Submit two signed and notarized original copies of each Application for Payment to Owner by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

- H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
  2. When an application shows completion of an item, submit conditional final or full waivers.
  3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
  4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
  5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- I. Maintain an updated set of drawings to be used as record drawings in accordance with Section 017839. As a prerequisite for monthly progress payments, exhibit the updated record drawings for review by Owner and Engineer for completeness and accuracy.
- J. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
  2. Schedule of values.
  3. Contractor's construction schedule.
  4. Products list (preliminary if not final).
  5. Schedule of unit prices.
  6. Submittal schedule.
  7. List of Contractor's staff assignments.
  8. Copies of building and trade permits.
  9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
- K. Application for Payment at Substantial Completion: After issuance of the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portions of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
  2. Include initial submittal of closeout record drawings in accordance with Section 017839.
  3. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- L. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
  2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.

3. Final submittal of closeout record drawings in accordance with Section 017839.
4. Updated final statement, accounting for final changes to the Contract Sum.
5. AIA Document G706.
6. AIA Document G706A.
7. AIA Document G707.
8. Evidence that claims have been settled.
9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
10. Final liquidated damages settlement statement.

M. Contractor must include purchase order number on all Pay Applications

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012900



## SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
1. General coordination procedures.
  2. Coordination drawings.
  3. RFIs.
  4. Digital project management procedures.
  5. Project meetings.
- B. Related Requirements:
1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
  2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
  3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
  4. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

#### 1.2 DEFINITIONS

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

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
  2. Number and title of related Specification Section(s) covered by subcontract.
  3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and in prominent location in built facility. Keep list current at all times.

#### 1.4 GENERAL COORDINATION PROCEDURES

- A. Coordination: Contractor shall cooperate with Owner who shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.
  1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
  3. Make adequate provisions to accommodate items scheduled for later installation.
- 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 scheduled activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  1. Preparation of Contractor's construction schedule.
  2. Preparation of the schedule of values.
  3. Installation and removal of temporary facilities and controls.
  4. Delivery and processing of submittals.
  5. Progress meetings.
  6. Preinstallation conferences.
  7. Project closeout activities.
  8. Startup and adjustment of systems.

#### 1.5 COORDINATION DRAWINGS

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



1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
  - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
  - b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
  - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
  - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
  - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
  - f. Indicate required installation sequences.
  - g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

#### 1.6 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Engineer.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  12. Contractor's signature.

13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
  - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Engineer.
  1. Attachments shall be electronic files in PDF format.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow fourteen working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
  1. The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.
    - f. Requests for interpretation of Engineer's actions on submittals.
    - g. Incomplete RFIs or inaccurately prepared RFIs.
  2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.
  3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
    - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Owner in writing within three days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log biweekly. Include the following:
  1. Project name.
  2. Name and address of Contractor.
  3. Name and address of Engineer.
  4. RFI number including RFIs that were returned without action or withdrawn.
  5. RFI description.
  6. Date the RFI was submitted.
  7. Date Engineer's response was received.
  8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.

#### 1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Engineer's Data Files: Engineer will provide Engineer's CAD drawing digital data files for Contractor's use during construction if requested in accordance with the General Conditions.
- B. Web-Based Project Software: Use Owner's web-based Project software site, eBuilder, for purposes of hosting and managing Project communication and documentation until Final Completion. Owner to provide up to two temporary licenses for contractor use. General Contractor shall be responsible for any additional cost associated with using web based software.
  1. Web-based Project software site includes, at a minimum, the following features:
    - a. Compilation of Project data, including Contractor, subcontractors, Engineer, architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
    - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
    - c. Document workflow planning, allowing customization of workflow between project entities.
    - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
    - e. Track status of each Project communication in real time, and log time and date when responses are provided.
    - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
    - g. Processing and tracking of payment applications.
    - h. Processing and tracking of contract modifications.
    - i. Creating and distributing meeting minutes.
    - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
    - k. Management of construction progress photographs.
    - l. Mobile device compatibility, including smartphones and tablets.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare as follows:
  1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
  2. Name file with submittal number or other unique identifier, including revision identifier.

3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

## 1.8 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated or directed by Owner.
  1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
  2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, and Engineer, within five days of the meeting.
- B. Preconstruction Conference: Owner will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Contractor, but no later than 30 days after execution of the Agreement.
  1. Attendees: Authorized representatives of Owner, Engineer; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Responsibilities and personnel assignments.
    - b. Tentative construction schedule.
    - c. Phasing.
    - d. Critical work sequencing and long lead items.
    - e. Designation of key personnel and their duties.
    - f. Lines of communications.
    - g. Use of web-based Project software.
    - h. Procedures for processing field decisions and Change Orders.
    - i. Procedures for RFIs.
    - j. Procedures for testing and inspecting.
    - k. Procedures for processing Applications for Payment.
    - l. Distribution of the Contract Documents.
    - m. Submittal procedures.
    - n. Sustainable design requirements.
    - o. Preparation of Record Documents.
    - p. Use of the premises and existing building.
    - q. Work restrictions.
    - r. Working hours.
    - s. Owner's occupancy requirements.
    - t. Responsibility for temporary facilities and controls.
    - u. Procedures for moisture and mold control.
    - v. Procedures for disruptions and shutdowns.
    - w. Construction waste management and recycling.
    - x. Parking availability.

- y. Office, work, and storage areas.
    - z. Equipment deliveries and priorities.
    - aa. First aid.
    - bb. Security.
    - cc. Progress cleaning.
    - dd. List of major subcontractors and suppliers.
  3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
  1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Owner or their agent of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    - a. Contract Documents.
    - b. Options.
    - c. Related RFIs.
    - d. Related Change Orders.
    - e. Purchases.
    - f. Deliveries.
    - g. Submittals.
    - h. Sustainable design requirements.
    - i. Review of mockups.
    - j. Possible conflicts.
    - k. Compatibility requirements.
    - l. Time schedules.
    - m. Weather limitations.
    - n. Manufacturer's written instructions.
    - o. Warranty requirements.
    - p. Compatibility of materials.
    - q. Acceptability of substrates.
    - r. Temporary facilities and controls.
    - s. Space and access limitations.
    - t. Regulations of authorities having jurisdiction.
    - u. Testing and inspecting requirements.
    - v. Installation procedures.
    - w. Coordination with other work.
    - x. Required performance results.
    - y. Protection of adjacent work.
    - z. Protection of construction and personnel.
  3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
  5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Engineer, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
  2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
    - a. Preparation of Record Documents.
    - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
    - c. Procedures for completing and archiving web-based Project software site data files.
    - d. Submittal of written warranties.
    - e. Requirements for completing sustainable design documentation.
    - f. Requirements for preparing operations and maintenance data.
    - g. Requirements for delivery of material samples, attic stock, and spare parts.
    - h. Requirements for demonstration and training.
    - i. Preparation of Contractor's punch list.
    - j. Procedures for processing Applications for Payment at Substantial Completion and for final payment including final change order.
    - k. Submittal procedures.
    - l. Coordination of separate contracts.
    - m. Owner's partial occupancy requirements including certificate of occupancy and closeout of permits.
    - n. Installation of Owner's furniture, fixtures, and equipment.
    - o. Responsibility for removing temporary facilities and controls.
    - p. Final cleaning.
  4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at biweekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
  2. Attendees: In addition to representatives of Owner, and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
  - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    - 1) Review schedule for next period.
  - b. Review present and future needs of each entity present, including the following:
    - 1) Interface requirements.
    - 2) Sequence of operations.
    - 3) Resolution of BIM component conflicts.
    - 4) Status of submittals.
    - 5) Status of sustainable design documentation.
    - 6) Deliveries.
    - 7) Off-site fabrication.
    - 8) Access.
    - 9) Site use.
    - 10) Temporary facilities and controls.
    - 11) Progress cleaning.
    - 12) Quality and work standards.
    - 13) Status of correction of deficient items.
    - 14) Field observations.
    - 15) Status of 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.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
  - a. Schedule Updating: Revise Contractor's construction schedule and submit with each Pay Application.
5. Contractor should provide a three-week look ahead and report on work done in the previous two weeks at this meeting.

Preliminary Treatment Upgrades (WPB2) Phase 9B  
Arlington, VA

Project Management and Coordination  
013100 - 10  
100% Design

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013100



## SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
  - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
  - 2. Predecessor Activity: An activity that precedes another activity in the network.
  - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. 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.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
  - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
  - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.

3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
1. Working electronic copy of schedule file, where indicated.
  2. PDF file.
  3. Two paper copies, of sufficient size to display entire period or schedule, as required.
- B. Startup construction schedule.
1. Submittal of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, latest allowable start date, latest allowable finish date, status (where critical) and total float and free float in calendar days.
1. Activity Report: List of 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 each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
  3. Total Float Report: List of activities sorted in ascending order of total float.
  4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at weekly intervals.
- H. Material Location Reports: Submit at monthly intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.

- J. Unusual Event Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.

#### 1.4 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Owner's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:
  - 1. Review software limitations and content and format for reports.
  - 2. Verify availability of qualified personnel needed to develop and update schedule.
  - 3. Discuss constraints, including work stages interim milestones. Owner shall maintain occupancy at all times.
  - 4. Review delivery dates for Owner-furnished products.
  - 5. Review schedule for work of Owner's separate contracts.
  - 6. Review submittal requirements and procedures.
  - 7. Review time required for review of submittals and resubmittals.
  - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
  - 9. Review time required for Project closeout and Owner startup procedures.
  - 10. Review and finalize list of construction activities to be included in schedule.
  - 11. Review procedures for updating schedule.
  - 12. Submit at this conference a preliminary network defining the planned operation during the first 60 calendar days after the Notice to Proceed.

#### 1.5 COORDINATION

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

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

- A. Program Description
  - 1. A Critical Path Method (CPM) construction schedule shall be used to control the Work and to provide a basis for determining job progress. The construction schedule shall be prepared and maintained by the Contractor. All work shall be done in accordance with

- the established CPM schedule. The Contractor and all subcontractors shall cooperate fully in developing the construction schedule and in executing the work in accordance with the CPM schedule.
2. The construction schedule shall consist of a computerized CPM network (diagram of activities) presented in a time-scaled graphic (print-out) with reports, as specified herein.
- B. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
1. Use Primavera, for current Windows operating system.
- C. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- D. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Owner.
  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.
    - a. Multi-Rake Bar Screens
    - b. Screw Bulk Material Conveyors
    - c. Screenings Washer, and Compactors
    - d. Scum Concentrator System
    - e. Structural Steel Framing
  3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
  4. Startup and Testing Time: Include no fewer than 21 days for startup and testing.
  5. Commissioning Time: Include no fewer than 30 days for commissioning.
  6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Owner's administrative procedures necessary for certification of Substantial Completion.
  7. Punch List and Final Completion: Include not more than 45 days for completion of punch list items and final completion.
- E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
  2. Work under More Than One Contract: Include a separate activity for each contract.
  3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.

4. Work Restrictions: Show the effect of the following items on the schedule:
  - a. Coordination with existing construction.
  - b. Limitations of continued occupancies.
  - c. Uninterruptible services.
  - d. Use-of-premises restrictions.
  - e. Provisions for future construction.
  - f. Seasonal variations.
  - g. Environmental control.
  
5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
  - a. Submittals.
  - b. Purchases.
  - c. Fabrication.
  - d. Sample testing.
  - e. Deliveries.
  - f. Installation.
  - g. Adjusting.
  - h. Curing.
  - i. Building flush-out.
  - j. Startup and placement into final use and operation.
  - k. Commissioning.
  
6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
  - a. Structural completion.
  - b. Completion of mechanical installation.
  - c. Completion of electrical installation.
  - d. Substantial Completion.
  
- F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
  
- G. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
  1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
  
- H. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
  1. Unresolved issues.
  2. Unanswered Requests for Information.
  3. Rejected or unreturned submittals.
  4. Notations on returned submittals.

5. Pending modifications affecting the Work and the Contract Time.

I. Acceptability

1. Submit the CPM schedule submittals, as specified, and resubmit as needed, until they are in compliance with Contract requirements.
2. The Owner's review of the Contractor's construction schedule submittals will only be for conformance with the Contract requirements – including but not limited to contract time and work sequences specified in the contract documents. The Owner's review of the schedule shall not include the Contractor's means and methods of construction or safety. The Owner's concurrence, acceptance, or approval of the Contractor's schedule submittals will not relieve the Contractor from responsibility for complying with the Contract Scope, Contract Time or any other contract requirement. Any indication of concurrence, acceptance, or approval of the Contractor's schedule will only indicate a general conformance with the Contract Requirements.
3. Owner's review of the Contractor's construction schedule submittals shall not relieve the Contractor from responsibility for any deviations from the Contract Documents unless the Contractor has in writing called Owner's attention to such deviations at the time of submission and Owner has given written concurrence to the specific deviations, nor shall any concurrence by the Owner relieve Contractor from responsibility for errors and omissions in the submittals. Concurrence of the CPM Activity Network by the Owner is advisory only and shall not relieve the Contractor of responsibility for accomplishing the Work within the Contract completion date(s).
4. Concurrence, acceptance, or approval of the Contractor's CPM schedule by the Owner in no way makes the Owner an insurer of the CPM schedule's success, nor liable for time or cost overruns resulting therefrom.
5. Failure to include any element of work required for the performance of this Contract will not excuse the Contractor from completing all Work required within the Contract completion date(s), notwithstanding the review of the network by the Owner.
6. CPM schedules that contain activities with negative float, or which extend beyond the contract completion date, will not be acceptable.
7. Except where earlier completions are specified, CPM schedules which show completion of all work prior to the contract completion date may be indicated; however, in no event shall they constitute a basis for claim for delay by the Contractor.

J. Contractor's Construction Schedule Updating: With each schedule payment application, update schedule to reflect actual construction progress and activities.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity. Activities shall not be considered to be complete until they are in fact 100 percent complete.
4. Submit a narrative report based on the CPM schedule evaluation, in a format agreed upon by the Contractor and the Owner. The report shall include a description of the progress during the previous period in terms of completed activities, an explanation of each activity which is showing a delay, a description of problem areas, current and anticipated delaying factors and their estimated impact on performance of other activities and completion dates and an explanation of corrective action taken or proposed.

- K. Recovery Schedule: When periodic update indicates the Work is 21 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- L. The contract completion time will be adjusted only for causes specified in this Contract. In the event the Contractor requests an extension of any contract completion date, the Contractor shall furnish such justification and supporting evidence as the Owner may deem necessary to determine whether the Contractor is entitled to an extension of time under the provisions of this Contract. The Owner will, after receipt of such justification and supporting evidence, make findings of fact and will advise the Contractor in writing thereof. If the Owner finds that the Contractor is entitled to any extension of any contract completion date, the Owner's determination as to the total number of days extension shall be based upon the currently approved CPM schedule and on all data relevant to the extension. Such data shall be included in the next updating of the schedule. Actual delays in activities which, according to the CPM schedule, do not affect any contract completion date shown by the critical path in the network will not be the basis for a change therein.
- M. Distribution: Distribute copies of approved schedule to Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
  - 1. Post copies in Project meeting rooms and temporary field offices.
  - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

#### 1.7 STARTUP CONSTRUCTION SCHEDULE

- A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within 15 days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

#### 1.8 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Proceed.
  - 1. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

## 1.9 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
  1. List of subcontractors at Project site.
  2. List of separate contractors at Project site.
  3. Approximate count of personnel at Project site.
  4. Equipment at Project site.
  5. Material deliveries.
  6. High and low temperatures and general weather conditions, including presence of rain or snow.
  7. Testing and inspection.
  8. Accidents.
  9. Meetings and significant decisions.
  10. Unusual events.
  11. Stoppages, delays, shortages, and losses.
  12. Meter readings and similar recordings.
  13. Emergency procedures.
  14. Orders and requests of authorities having jurisdiction.
  15. Change Orders received and implemented.
  16. Work Change Directives received and implemented.
  17. Services connected and disconnected.
  18. Equipment or system tests and startups.
  19. Partial completions and occupancies.
  20. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, with Pay Application, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
  1. Material stored prior to previous report and remaining in storage.
  2. Material stored prior to previous report and since removed from storage and installed.
  3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.



1. Submit unusual event reports directly to Owner within three calendar days of an occurrence. Distribute copies of report to parties affected by the occurrence.
- E. Contractor shall submit Construction Progress Photos, monthly, labeled and on a CD or thumb drive. Photos should provide clear pictures showing progress and work completed that month.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013200



## SECTION 013300 - SUBMITTAL PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

##### B. Related Requirements:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
4. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
5. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
8. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

#### 1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. Mass Submittals: Six or more submittals or items in one day or 15 or more submittals or items in one week.

### 1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
  2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
  3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
    - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
  4. Format: Arrange the following information in a tabular format:
    - a. Scheduled date for first submittal.
    - b. Specification Section number and title.
    - c. Submittal Category: Action; informational.
    - d. Name of subcontractor.
    - e. Description of the Work covered.
    - f. Scheduled date for Engineer's final release or approval.
    - g. Scheduled dates for purchasing.
    - h. Scheduled date of fabrication.
    - i. Scheduled dates for installation.
    - j. Activity or event number.

### 1.4 SUBMITTAL FORMATS

- A. Numbering System: Utilize the following example submittal identification numbering system to identify submittals and as file names for PDF submissions:
1. First Identifier - Alphabet Character: D, S, M or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.
  2. Second Identifier - Next 6 or 8 Digits: Applicable Specification Section Number. Do not mix submittals from different specification sections into a single submittal.
  3. Third Identifier - Next Three Digits: Sequential number of each separate item or drawing submitted under each Specification Section, in chronological order submitted, starting at 001.
  4. Fourth Identifier - Last Alphabet Character: A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc.
  5. EXAMPLE: D-033000.13-008-B.

- a. D = Shop Drawing.
  - b. 03 30 00.13 = Section; use only 6 digits for sections that do not include 8 digits.
  - c. 008 = the eighth different submittal under this Section.
  - d. B = the second submission (first resubmission) of that particular shop drawing.
- B. Submittal Information: Utilized the attached submittal template, which shall include the following information in each submittal:
1. Project name.
  2. Date.
  3. Name of Engineer.
  4. Name of Contractor.
  5. Name of firm or entity that prepared submittal.
  6. Names of subcontractor, manufacturer, and supplier.
  7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
  8. Category and type of submittal.
  9. Submittal purpose and description.
  10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
  11. Drawing number and detail references, as appropriate.
  12. Indication of full or partial submittal.
  13. Location(s) where product is to be installed, as appropriate.
  14. Other necessary identification.
  15. Remarks.
  16. Signature of transmitter.
- C. Options: Identify options requiring selection by Engineer.
- D. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer or Owner on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- E. Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- F. Submittals for Web-Based Project Software: Prepare submittals as PDF files, or other format indicated by Project software website.

## 1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.

2. Paper: Prepare submittals in paper form, and deliver to Owner.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 30 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow 20 days for review of each resubmittal.
  4. Sequential Review: Where sequential review of submittals by Owner's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
  2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
  4. Repetitive Reviews: Shop drawings, O&M manuals, and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will be performed at the Contractor's expense. Reimburse the Owner for all costs invoiced by Engineer for the third and subsequent reviews.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

## 1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.
  3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams that show factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
  2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
    - a. Provide electronic copies of each submittal. Printed paper copies will only be provided if asked by the Engineer or Owner.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
  - a. Project name and submittal number.
  - b. Generic description of Sample.
  - c. Product name and name of manufacturer.
  - d. Sample source.
  - e. Number and title of applicable Specification Section.
  - f. Specification paragraph number and generic name of each item.
3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
4. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
  - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
  - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
7. 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 two full sets of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
8. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  - a. Number of Samples: Submit three sets of Samples. Owner will retain two Sample sets; remainder will be returned.
    - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.



- 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
  2. Manufacturer and product name, and model number if applicable.
  3. Number and name of room or space.
  4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
  2. Contractor's Certification: Each shop drawing, working drawing, product data, and sample shall have affixed to it the following Certification Statement:
    - a. "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements. "
  3. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
  4. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
  5. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
  6. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
  7. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding

Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - a. Name of evaluation organization.
  - b. Date of evaluation.
  - c. Time period when report is in effect.
  - d. Product and manufacturers' names.
  - e. Description of product.
  - f. Test procedures and results.
  - g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Owner.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

#### 1.8 PROPOSED PRODUCT LIST

- A. Within 15 days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

#### 1.9 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Owner.
- B. Contractor Responsible for:
  1. Determination and verification of materials including manufacturer's catalog numbers.
  2. Determination and verification of field measurements and field construction criteria.
  3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
  4. Determination of accuracy and completeness of dimensions and quantities.
  5. Confirmation and coordination of dimensions and field conditions at Site.
  6. Construction means, techniques, sequences, and procedures.
  7. Safety precautions.
  8. Coordination and performance of Work of all trades.
  9. Other requirements enumerated in Contract Documents.
- C. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
  1. Owner will not review submittals received from Contractor that do not have Contractor's review and approval.

#### 1.10 ENGINEER'S REVIEW

- A. Do not make mass submittals to Engineer. If mass submittals are received, Engineer's review time stated above will be extended as necessary to perform proper review. Engineer will review mass submittals based on priority determined by Engineer after consultation with Owner and Contractor.
- B. Action Submittals: Engineer will review each submittal, indicate corrections or revisions required, and return it.

1. PDF Submittals: Engineer will indicate, via markup on each submittal, the appropriate action.
  2. Submittals by Web-Based Project Software: Engineer will indicate, on Project software website, the appropriate action.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.
- E. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- F. Engineer will discard submittals received from sources other than Contractor.
- G. Submittals not required by the Contract Documents will be returned by Engineer without action.
- H. Shop drawings will be returned to the Contractor with one of the following codes.
1. "APPROVED" - This code is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.
  2. "APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.
  3. "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. The resubmittal is to address all comments, omissions and non-conforming items that were noted. An additional box is checked to indicate whether the resubmission is for the complete package, or for parts of the package. If no box is checked, a complete resubmittal shall be provided. Review code may designate if a partial or full submittal is required. If full submittal is required, a complete resubmittal package addressing all comments shall be provided. If a partial submittal is designated, resubmittal shall only include information pertaining to those items noted in review comments requiring clarification and any portions of submittal impacted as a result of the response. Resubmittal is to be received by the Engineer within 30 calendar days of the date of the Engineer's transmittal requiring the resubmittal.
  4. "REVISE AND RESUBMIT" - This code is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the Contract Documents.
  5. "RECEIPT ACKNOWLEDGED (Not subject to Engineer's Approval)" - This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's approval. This code is generally used with submittals involving the Contractor's means and methods of construction work plans, and health and safety plans.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013300



## SECTION 013516 - ALTERATION PROJECT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes special procedures for alteration work.

#### 1.2 DEFINITIONS

- A. **Alteration Work:** This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. **Consolidate:** To strengthen loose or deteriorated materials in place.
- C. **Design Reference Sample:** A sample that represents the Engineer's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.
- D. **Dismantle:** To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- E. **Match:** To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Engineer.
- F. **Refinish:** To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. **Repair:** To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. **Replace:** To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. **Replicate:** To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. **Reproduce:** To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. **Retain:** To keep existing items that are not to be removed or dismantled.
- L. **Strip:** To remove existing finish down to base material unless otherwise indicated.

### 1.3 COORDINATION

- A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.
1. Schedule construction operations in sequence required to obtain best Work results.
  2. Coordinate sequence of alteration work activities to accommodate the following:
    - a. Owner's continuing occupancy of portions of existing building.
    - b. Owner's partial occupancy of completed Work.
    - c. Other known work in progress.
    - d. Tests and inspections.
  3. Detail sequence of alteration work, with start and end dates.
  4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services with OWNER.
  5. Use of elevator and stairs.
  6. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns within Project building(s) and site. Some work is near circulation patterns and adjacent to restricted areas. Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work. Access to restricted areas may not be obstructed. Plan and execute the Work accordingly.

### 1.4 PROJECT MEETINGS FOR ALTERATION WORK

- A. Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site.
1. Attendees: In addition to representatives of Owner, Engineer, and Contractor, testing service representative, specialists, and chemical-cleaner manufacturer(s) shall be represented at the meeting.
  2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
    - a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Fire-prevention plan.
    - c. Governing regulations.
    - d. Areas where existing construction is to remain and the required protection.
    - e. Hauling routes.
    - f. Sequence of alteration work operations.
    - g. Storage, protection, and accounting for salvaged and specially fabricated items.



- h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
  - i. Qualifications of personnel assigned to alteration work and assigned duties.
  - j. Requirements for extent and quality of work, tolerances, and required clearances.
  - k. Embedded work such as flashings and lintels, special details, collection of waste, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.
3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.

## 1.5 INFORMATIONAL SUBMITTALS

### A. Alteration Work Subschedule:

1. Submit alteration work subschedule within 30 days of date established for commencement of alteration work.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration work operations.

## 1.6 QUALITY ASSURANCE

### A. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.

1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.

### B. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.

### C. Safety and Health Standard: Comply with ANSI/ASSE A10.6.

## 1.7 STORAGE AND HANDLING OF SALVAGED MATERIALS

### A. Salvaged Materials:

1. Clean loose dirt and debris from salvaged items unless more extensive cleaning is indicated.
2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Protect items from damage during transport and storage.

B. Salvaged Materials for Reinstallation:

1. Repair and clean items for reuse as indicated.
2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.

C. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Engineer, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.

D. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.

1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
2. Secure stored materials to protect from theft.
3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F or more above the dew point.

E. Storage Space:

1. Owner will arrange for limited on-site location(s) for free storage of salvaged material. This storage space does not include security and climate control for stored material.
2. Arrange for off-site locations for storage and protection of salvaged material that cannot be stored and protected on-site.

## 1.8 FIELD CONDITIONS

- A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of measured drawings, preconstruction photographs and preconstruction videotapes.
- B. Discrepancies: Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
  - 1. Use only proven protection methods, appropriate to each area and surface being protected.
  - 2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
  - 3. Erect temporary barriers to form and maintain fire-egress routes.
  - 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
  - 5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
  - 6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
  - 7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
  - 8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.
- B. Temporary Protection of Materials to Remain:
  - 1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
  - 2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
  - 1. Notify Owner, Engineer, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
  - 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
  - 3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Engineer immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly. This applies to interior and exterior drains associated with work areas.

1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from alteration work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

### 3.2 PROTECTION FROM FIRE

#### A. General: Follow fire-prevention plan and the following:

1. Comply with NFPA 241 requirements unless otherwise indicated.
2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
  - a. If combustible material cannot be removed, provide fire blankets to cover such materials.

#### B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:

1. Obtain Owner's approval for operations involving use of welding or other high-heat equipment. Use of open-flame equipment is not permitted. Notify Owner at least 72 hours before each occurrence, indicating location of such work.
2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
  - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
  - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
  - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
  - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
  - e. Maintain fire-watch personnel at each area of Project site until thirty minutes after conclusion of daily work.

- C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.
- D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.
  - 1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

### 3.3 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

### 3.4 GENERAL ALTERATION WORK

- A. Have specialty work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings.
- D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
- E. Notify Owner and Engineer of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
  - 1. Do not proceed with the work in question until directed by Engineer.

END OF SECTION 013516

## SECTION 014000 - QUALITY REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
  - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
  - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
  - 4. Specific test and inspection requirements are not specified in this Section.

#### 1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
  - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to

NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

- F. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer or Owner.

### 1.3 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

### 1.4 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

### 1.5 DELEGATED DESIGN

- A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or



certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1. Delegated-Designer: All delegated designs must be signed and sealed by a Professional Engineer with active registration in the Commonwealth of Virginia.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel and Delegated-Designer.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
  1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
  2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
  1. Specification Section number and title.
  2. Entity responsible for performing tests and inspections.
  3. Description of test and inspection.
  4. Identification of applicable standards.
  5. Identification of test and inspection methods.
  6. Number of tests and inspections required.
  7. Time schedule or time span for tests and inspections.
  8. Requirements for obtaining samples.
  9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

## 1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice of Award, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
  - 1. Project quality-control manager shall not have other Project responsibilities without specific approval from the Owner.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
  - 1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
  - 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

## 1.8 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address, telephone number, and email address of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making tests and inspections.

6. Description of the Work and test and inspection method.
  7. Identification of product and Specification Section.
  8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Recommendations on retesting and reinspecting.
- B. **Manufacturer's Technical Representative's Field Reports:** Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
  2. Statement on condition of substrates and their acceptability for installation of product.
  3. Statement that products at Project site comply with requirements.
  4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  6. Statement whether conditions, products, and installation will affect warranty.
  7. Other required items indicated in individual Specification Sections.
- C. **Factory-Authorized Service Representative's Reports:** Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
  2. Statement that equipment complies with requirements.
  3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  4. Statement whether conditions, products, and installation will affect warranty.
  5. Other required items indicated in individual Specification Sections.

## 1.9 QUALITY ASSURANCE

- A. **General:** Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
  - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
  - 1. Contractor responsibilities include the following:
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
  - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

## 1.10 QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  2. Engage a qualified testing agency to perform quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
  4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- C. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform duties of Contractor.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and

conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

- F. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
  4. Facilities for storage and field curing of test samples.
  5. Delivery of samples to testing agencies.
  6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  7. Security and protection for samples and for testing and inspection equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Engineer testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

#### 1.11 SPECIAL TESTS AND INSPECTIONS

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

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

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
  2. Description of the Work tested or inspected.
  3. Date test or inspection results were transmitted to Engineer.
  4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

### 3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.

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

END OF SECTION 014000



## SECTION 014200 - REFERENCES

### PART 1 - GENERAL

#### 1.1 DEFINITIONS

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

#### 1.2 INDUSTRY STANDARDS

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

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

### 1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. AABC - Associated Air Balance Council; [www.aabc.com](http://www.aabc.com).
  2. AAMA - American Architectural Manufacturers Association; [www.aamanet.org](http://www.aamanet.org).
  3. AAPFCO - Association of American Plant Food Control Officials; [www.aapfco.org](http://www.aapfco.org).
  4. AASHTO - American Association of State Highway and Transportation Officials; [www.transportation.org](http://www.transportation.org).
  5. AATCC - American Association of Textile Chemists and Colorists; [www.aatcc.org](http://www.aatcc.org).
  6. ABMA - American Bearing Manufacturers Association; [www.americanbearings.org](http://www.americanbearings.org).
  7. ABMA - American Boiler Manufacturers Association; [www.abma.com](http://www.abma.com).
  8. ACI - American Concrete Institute; (Formerly: ACI International); [www.concrete.org](http://www.concrete.org)
  9. ACPA - American Concrete Pipe Association; [www.concrete-pipe.org](http://www.concrete-pipe.org).
  10. AEIC - Association of Edison Illuminating Companies, Inc. (The); [www.aeic.org](http://www.aeic.org).
  11. AF&PA - American Forest & Paper Association; [www.afandpa.org](http://www.afandpa.org).
  12. AGA - American Gas Association; [www.aga.org](http://www.aga.org).
  13. AHAM - Association of Home Appliance Manufacturers; [www.aham.org](http://www.aham.org).
  14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); [www.ahrinet.org](http://www.ahrinet.org).
  15. AI - Asphalt Institute; [www.asphaltinstitute.org](http://www.asphaltinstitute.org).
  16. AIA - American Institute of Architects (The); [www.aia.org](http://www.aia.org).
  17. AISC - American Institute of Steel Construction; [www.aisc.org](http://www.aisc.org).
  18. AISI - American Iron and Steel Institute; [www.steel.org](http://www.steel.org).
  19. AITC - American Institute of Timber Construction; [www.aitc-glulam.org](http://www.aitc-glulam.org).
  20. AMCA - Air Movement and Control Association International, Inc.; [www.amca.org](http://www.amca.org).
  21. ANSI - American National Standards Institute; [www.ansi.org](http://www.ansi.org).
  22. AOSA - Association of Official Seed Analysts, Inc.; [www.aosaseed.com](http://www.aosaseed.com).
  23. APA - APA - The Engineered Wood Association; [www.apawood.org](http://www.apawood.org).
  24. APA - Architectural Precast Association; [www.archprecast.org](http://www.archprecast.org).
  25. API - American Petroleum Institute; [www.api.org](http://www.api.org).
  26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
  27. ARI - American Refrigeration Institute; (See AHRI).
  28. ARMA - Asphalt Roofing Manufacturers Association; [www.asphaltroofing.org](http://www.asphaltroofing.org).
  29. ASCE - American Society of Civil Engineers; [www.asce.org](http://www.asce.org).
  30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
  31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; [www.ashrae.org](http://www.ashrae.org).

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

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

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

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

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.



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

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; [www.usace.army.mil](http://www.usace.army.mil).
2. CPSC - Consumer Product Safety Commission; [www.cpsc.gov](http://www.cpsc.gov).
3. DOC - Department of Commerce; National Institute of Standards and Technology; [www.nist.gov](http://www.nist.gov).
4. DOD - Department of Defense; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
5. DOE - Department of Energy; [www.energy.gov](http://www.energy.gov).
6. EPA - Environmental Protection Agency; [www.epa.gov](http://www.epa.gov).
7. FAA - Federal Aviation Administration; [www.faa.gov](http://www.faa.gov).
8. FG - Federal Government Publications; [www.gpo.gov/fdsys](http://www.gpo.gov/fdsys).
9. GSA - General Services Administration; [www.gsa.gov](http://www.gsa.gov).
10. HUD - Department of Housing and Urban Development; [www.hud.gov](http://www.hud.gov).
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; [www.eetd.lbl.gov](http://www.eetd.lbl.gov).
12. OSHA - Occupational Safety & Health Administration; [www.osha.gov](http://www.osha.gov).
13. SD - Department of State; [www.state.gov](http://www.state.gov).
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; [www.trb.org](http://www.trb.org).
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; [www.ars.usda.gov](http://www.ars.usda.gov).
16. USDA - Department of Agriculture; Rural Utilities Service; [www.usda.gov](http://www.usda.gov).
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; [www.ojp.usdoj.gov](http://www.ojp.usdoj.gov).
18. USP - U.S. Pharmacopeial Convention; [www.usp.org](http://www.usp.org).
19. USPS - United States Postal Service; [www.usps.com](http://www.usps.com).

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; [www.gpo.gov/fdsys](http://www.gpo.gov/fdsys).
2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from DLA Document Services; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
  - a. Available from Defense Standardization Program; [www.dsp.dla.mil](http://www.dsp.dla.mil).
  - b. Available from General Services Administration; [www.gsa.gov](http://www.gsa.gov).

- c. Available from National Institute of Building Sciences/Whole Building Design Guide; [www.wbdg.org/ccb](http://www.wbdg.org/ccb).
  6. MILSPEC - Military Specification and Standards; (See DOD).
  7. USAB - United States Access Board; [www.access-board.gov](http://www.access-board.gov).
  8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).
- F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. DEQ: Virginia Department of Environmental Quality
  2. ISD: Arlington County Inspection Services Division

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 014200



## SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

#### 1.2 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.
- C. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- D. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

- D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.
- F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
  - 1. Locations of dust-control partitions at each phase of work.
  - 2. HVAC system isolation schematic drawing.
  - 3. Location of proposed air-filtration system discharge.
  - 4. Waste-handling procedures.
  - 5. Other dust-control measures.

#### 1.4 QUALITY ASSURANCE

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

#### 1.5 PROJECT CONDITIONS

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

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. 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.
- B. Portable 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 and bottom rails. Provide galvanized-steel bases for supporting posts.

- C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Engineer from manufacturer's standard colors.
- D. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-milminimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.
- E. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches.

## 2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Provide prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
  - 1. Store combustible materials apart from building.

## 2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
  - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
  - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
  - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction. and clean HVAC system as required in Section 017700 "Closeout Procedures."
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

## PART 3 - EXECUTION

### 3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
  - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

### 3.2 INSTALLATION, GENERAL

- A. Locate facilities where shown on the Drawings or where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work. Engineer's trailer shall be set up and ready for occupancy within 30 days of the Notice to Proceed.
  - 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use within 30 days of the Notice to Proceed and prior to Commencement of Work at the site.

### 3.3 CONTRACTOR'S FIELD OFFICE

- A. Provide a temporary field office(s) for the Contractor's use for the duration of the project. An authorized representative of the Contractor shall be present at all times while the Work is in progress. Instructions received at the Contractors field office from the Engineer shall be considered delivered to the Contractor.
- B. Locate field office(s) in accordance with approved shop drawings and as directed by the Owner.
- C. Establish and occupy field office within 30 days of the Notice to Proceed, unless otherwise approved by the Engineer or Owner.

### 3.4 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service, if approved by Owner.
  - 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.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

- D. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Final Completion, restore these facilities to condition existing before initial use.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities. Use of Owner's sanitary facilities is prohibited.
- F. Temporary 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.
  - 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
  - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
    - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
    - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
  - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
  - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- H. The Contractor shall furnish temporary light and power, including 220 Volt service for welding, complete with wiring, lamps and similar equipment as required to adequately light all work areas and with sufficient power capacity to meet the project needs, and comply with NFPA requirements for classified spaces. Make all necessary arrangements with the local electric company for temporary electric service and pay all expenses in connection therewith.
- I. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- J. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
  - 1. Connect temporary service to Owner's existing power source, as directed by Owner.

- K. 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.

### 3.5 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
  - 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
  - 2. Maintain support facilities until Engineer schedules Final Completion inspection. Remove just before Final Completion.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings.
  - 1. Provide dust-control treatment that is nonpolluting and nontracking. 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: Use designated areas of Owner's existing 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 or endanger permanent Work or temporary facilities.
  - 2. Remove snow and ice as required to minimize accumulations.
- F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
  - 1. Identification Signs: Provide Project identification signs as indicated on Drawings. Signs shall be constructed of A-A Ext – APA grade plywood, 1-in thick. Posts and braces shall be of pressure treated lumber.
  - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  - 3. Maintain and touch up signs so they are legible at all times.

- G. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- I. 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.
  - 2. Inspect cranes and hoists at the Contractor's expense before and after use.
    - a. The County will pay for any repairs needed after the "before" inspection.
    - b. The Contractor will pay for any repairs needed after the "after" inspection.
- J. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

### 3.6 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
  - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
  - 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- D. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- E. 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.
- F. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

- G. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
  - 1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
  - 2. Paint and maintain appearance of walkway for duration of the Work.
- H. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
  - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
  - 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.
- I. Weather protection shall comply with M.G.L. Chapter 149 Section 44G.

### 3.7 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
  - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
  - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
  - 3. Indicate methods to be used to avoid trapping water in finished work.

### 3.8 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.



2. Clear snow and ice from all drives, walks and stairs to maintain safe vehicle and pedestrian access to the site and facilities as directed by the Engineer.
- C. 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 Final Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
  2. Just prior to Final Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000



## SECTION 016000 - PRODUCT REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
  - 1. Section 012300 "Alternates" for products selected under an alternate.
  - 2. Section 012500 "Substitution Procedures" for requests for substitutions.
  - 3. Section 014200 "References" for applicable industry standards for products specified.

#### 1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved by Engineer through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that

does meet the requirements of the specifications. Submit a comparable product request, if applicable.

### 1.3 ACTION SUBMITTALS

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
  - 2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
    - a. Form of Engineer's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
    - b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

### 1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
  - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
  - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
  - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
    - a. Name of product and manufacturer.

- b. Model and serial number.
  - c. Plant equipment tag.
  - d. Capacity/Range.
  - e. Speed.
  - f. Ratings.
3. See individual identification sections in Divisions 26 and 40 for additional identification requirements.

## 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
  1. Store products to allow for inspection and measurement of quantity or counting of units.
  2. Store materials in a manner that will not endanger Project structure.
  3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
  5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  6. Protect stored products from damage and liquids from freezing.
  7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

## 1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. **Manufacturer's Warranty:** Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  2. **Special Warranty:** Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. **Special Warranties:** Prepare a written document that contains appropriate terms and identification, ready for execution.
1. **Manufacturer's Standard Form:** Modified to include Project-specific information and properly executed.
  2. **Specified Form:** When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
  3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. **Submittal Time:** Comply with requirements in Section 017700 "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. **General Product Requirements:** Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. **Standard Products:** If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," Engineer will make selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
  6. **Or Equal:** For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
    - a. Submit additional documentation required by Engineer in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Engineer, whose determination is final.
- B. **Product Selection Procedures:**
1. **Sole Product:** Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

- a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
  - a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: ..."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
  - a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: ..."
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
  - a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: ..."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
  - a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: ..."
7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

- a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require "match Engineer's sample," provide a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.
  1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:
  1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
  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 Engineers and owners, if requested.
  5. Samples, if requested.
- B. Submittal Requirements: Approval by the Engineer of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

## PART 3 - EXECUTION (NOT USED)

END OF SECTION 016000



## SECTION 017300 - EXECUTION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Field engineering and surveying.
  - 3. Installation of the Work.
  - 4. Cutting and patching.
  - 5. Progress cleaning.
  - 6. Starting and adjusting.
  - 7. Protection of installed construction.
  
- B. Related Requirements:
  - 1. Section 011000 "Summary" for limits on use of Project site.
  - 2. Section 013300 "Submittal Procedures" for submitting surveys.
  - 3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
  - 4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

#### 1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
  
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

#### 1.3 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at 3402 S. Glebe Road, Arlington, VA 22202.
  - 1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
    - a. Contractor's superintendent.
    - b. Trade supervisor responsible for cutting operations.

- c. Trade supervisor(s) responsible for patching of each type of substrate.
  - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.
2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor or professional engineer.
- B. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
  1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
  2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
  3. Products: List products to be used for patching and firms or entities that will perform patching work.
  4. Dates: Indicate when cutting and patching will be performed.
  5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
    - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

#### 1.5 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
  1. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in decreased operational life or safety. Any cutting and patching resulting in increased maintenance shall be approved by the Owner at least 7 days prior to initiating cutting and patching. Operational elements include the following:
    - a. Primary operational systems and equipment.
    - b. Fire separation assemblies.
    - c. Air or smoke barriers.
    - d. Plumbing piping systems.
    - e. Mechanical systems piping and ducts.
    - f. Control systems.
    - g. Fire-detection and -alarm systems.
    - h. Conveying systems.
    - i. Electrical wiring systems.
  3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety, including.
    - a. Water, moisture, or vapor barriers.
    - b. Membranes and flashings.
    - c. Equipment supports.
    - d. Piping, ductwork, vessels, and equipment.
  4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services; and other utilities.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work.
  2. List of detrimental conditions, including substrates.
  3. List of unacceptable installation tolerances.
  4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer according to requirements in Section 013100 "Project Management and Coordination."

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
- B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish limits on use of Project site.
  - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 4. Inform installers of lines and levels to which they must comply.
  - 5. Check the location, level and plumb, of every major element as the Work progresses.
  - 6. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
  - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer.

### 3.4 INSTALLATION

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

4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
  - B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
  - C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
  - D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
  - E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
  - F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.
  - G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
  - H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
    1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
    2. Allow for building movement, including thermal expansion and contraction.
    3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
  - I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
  - J. Repair or remove and replace damaged, defective, or nonconforming Work.
    1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.
- 3.5 CUTTING AND PATCHING
- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  5. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
  1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### 3.6 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
  4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.



- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls." and Section 017419 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.7 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

### 3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300



## SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
  - 1. Salvaging nonhazardous waste.
  - 2. Recycling nonhazardous waste.
  - 3. Disposing of nonhazardous waste.
- B. Related Requirements:
  - 1. 024119 “Selective Demolition” for disposal of demolished materials.

#### 1.2 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner’s property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

#### 1.3 MATERIALS OWNERSHIP

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

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

#### 1.4 ACTION SUBMITTALS

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

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:
  1. Material category.
  2. Generation point of waste.
  3. Total quantity of waste in tons.
  4. Quantity of waste salvaged, both estimated and actual in tons.
  5. Quantity of waste recycled, both estimated and actual in tons.
  6. Total quantity of waste recovered (salvaged plus recycled) in tons.
  7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

#### 1.6 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may serve as Waste Management Coordinator.
- B. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

#### 1.7 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

## PART 2 - PRODUCTS – NOT USED

## PART 3 - EXECUTION

### 3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
  - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
  - 2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

### 3.2 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in Section 024119 "Selective Demolition" for salvaging demolition waste.

### 3.3 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
  - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.
- C. Burning: Do not burn waste materials.

- D. All waste containers must be covered to prevent stormwater contamination and/or reduce vector attractants.

END OF SECTION 017419

## SECTION 017700 - CLOSEOUT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures.
  - 2. Final completion procedures.
  - 3. Warranties.
  - 4. Final cleaning.
- B. Related Requirements:
  - 1. Section 012900 " Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
  - 2. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
  - 3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
  - 4. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

#### 1.2 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Engineer's use prior to Engineer's inspection, to determine if the Work is substantially complete.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

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

## 1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
  - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
  - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.
    - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer's signature for receipt of submittals.
  - 5. Submit changeover information related to Owner's use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
  - 1. Advise Owner of pending insurance changeover requirements.
  - 2. Complete startup and testing of systems and equipment.
  - 3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
  - 4. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  - 5. Complete final cleaning requirements.
  - 6. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.



- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
  2. Results of completed inspection will form the basis of requirements for final completion.

## 1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
  2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  4. Submit final completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine when the work is completed and ready for final inspection and tests. On receipt of request, Engineer and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

## 1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
  2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
  3. Include the following information at the top of each page:
    - a. Project name.

- b. Date.
  - c. Name of Engineer.
  - d. Name of Contractor.
  - e. Page number.
4. Submit list of incomplete items in the following format:
- a. MS Excel electronic file. Owner will return annotated file.
  - b. PDF electronic file. Owner will return annotated file.
  - c. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).

## 1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
  1. Submit by uploading to web-based project software site.
- D. Warranties in Paper Form:
  1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch 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.
- E. 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, environment or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

## PART 3 - EXECUTION

### 3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - d. Remove labels that are not permanent.
    - e. Wipe surfaces of installed equipment.
- C. Construction Waste Disposal: Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

### 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700



## SECTION 017823 - OPERATION AND MAINTENANCE DATA

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory manuals.
  - 2. Emergency manuals.
  - 3. Systems and equipment operation manuals.
  - 4. Systems and equipment maintenance manuals.
  - 5. Product maintenance manuals.
- B. Related Requirements:
  - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
  - 2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

#### 1.2 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
  - 1. Submit two copies on digital media acceptable to Engineer. Enable reviewer comments on draft submittals.
  - 2. Submit three paper copies. Engineer will return two copies.

- C. Initial Manual Submittal: Submit draft copy of each manual at least 60 days before commencing demonstration and training. Engineer will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 30 days before commencing demonstration and training. Engineer will return copy with comments.
  - 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

#### 1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
  - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for OCR format and minimum readable file size.
  - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file. Each bookmarked section should also contain bookmarks within it for each section, such as preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information, etc.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
  - 1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets. Dividers within each section must match the requested bookmarks of the electronic version. Example: preventive

maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information, etc.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. 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.

#### 1.5 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  1. Title page.
  2. Table of contents.
  3. Manual contents.
- B. Title Page: Include the following information:
  1. Subject matter included in manual.
  2. Name and address of Project.
  3. Name and address of Owner.
  4. Date of submittal.
  5. Name and contact information for Contractor.
  6. Name and contact information for Engineer.
  7. Cross-reference to related systems in other operation and maintenance manuals.
  8. Specification section number.
- 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.
  1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

- D. **Manual Contents:** Manual contents should be coordinated with Section 017823. 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.
- E. **Identification:** In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

## 1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. **Operation and Maintenance Documentation Directory:** Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
  - 1. **List of Systems and Subsystems:** List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
  - 2. **List of Equipment:** List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
  - 3. **Tables of Contents:** Include a table of contents for each emergency, operation, and maintenance manual.

## 1.7 EMERGENCY MANUALS

- A. **Emergency Manual:** Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. **Content:** Organize manual into a separate section for each of the following:
  - 1. Type of emergency.
  - 2. Emergency instructions.
  - 3. Emergency procedures.
- C. **Type of Emergency:** Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
  - 1. Fire.
  - 2. Flood.
  - 3. Gas leak.
  - 4. Water leak.
  - 5. Power failure.
  - 6. Water outage.
  - 7. System, subsystem, or equipment failure.
  - 8. Chemical release or spill.



- D. 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.
- E. Emergency Procedures: Include the following, as applicable:
  - 1. Instructions on stopping.
  - 2. Shutdown instructions for each type of emergency.
  - 3. Operating instructions for conditions outside normal operating limits.
  - 4. Required sequences for electric or electronic systems.
  - 5. Special operating instructions and procedures.

## 1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
  - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information as applicable:
  - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  - 2. Performance and design criteria if Contractor has delegated design responsibility.
  - 3. Equipment overview form.
  - 4. Operating standards.
  - 5. Operating procedures.
  - 6. Operating logs.
  - 7. Wiring diagrams.
  - 8. Control diagrams.
  - 9. Piped system diagrams.
  - 10. Precautions against improper use.
  - 11. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
  - 1. Product name and model number. Use designations for products indicated on Contract Documents.
  - 2. Manufacturer's name.
  - 3. Equipment tag number
  - 4. Equipment identification with serial number of each component.
  - 5. Equipment function.
  - 6. Operating characteristics.
  - 7. Limiting conditions.

8. Performance curves.
  9. Engineering data and tests.
  10. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
  2. Equipment or system break-in procedures.
  3. Routine and normal operating instructions.
  4. Regulation and control procedures.
  5. Instructions on stopping.
  6. Normal shutdown instructions.
  7. Seasonal and weekend operating instructions.
  8. Required sequences for electric or electronic systems.
  9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

#### 1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include an equipment overview form, manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information. Provide ISA data sheets for all equipment.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. 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 warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and equipment tag number, 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 and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; 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.
    - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
  2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  3. Identification and nomenclature of parts and components.
  4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
  2. Troubleshooting guide.
  3. Precautions against improper maintenance.
  4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  5. Aligning, adjusting, and checking instructions.
  6. Demonstration and training video recording, if available.
- F. 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.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
  2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. 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.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.
- J. 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 maintenance manuals.

#### 1.10 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. 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.
- C. 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 and drawing or schedule designation or identifier where applicable.
- D. 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.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
  1. Inspection procedures.
  2. Types of cleaning agents to be used and methods of cleaning.
  3. List of cleaning agents and methods of cleaning detrimental to product.
  4. Schedule for routine cleaning and maintenance.
  5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017823

## SECTION 017839 - PROJECT RECORD DOCUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
  - 1. Record Drawings.
  - 2. Miscellaneous record submittals.
- B. Related Requirements:
  - 1. Section 017300 "Execution" for final property survey.
  - 2. Section 017700 "Closeout Procedures" for general closeout procedures.
  - 3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

#### 1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: As noted below.
  - 2. Number of Copies: Submit copies of record Drawings as follows:
    - a. Initial Submittal:
      - 1) Submit one paper-copy set(s) of marked-up record prints.
      - 2) Submit PDF electronic files of scanned record prints.
      - 3) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
    - b. Final Submittal:
      - 1) Submit three paper-copy sets of marked-up record prints.
      - 2) Submit PDF electronic files of scanned record prints and three set of prints.
      - 3) Print each drawing, whether or not changes and additional information were recorded.
    - c. Final Submittal:
      - 1) Submit record digital data files and one set(s) of PDF file scans of record drawings.
- B. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one paper copy annotated PDF electronic files and directories of each submittal.

- C. Reports: Submit written report monthly with the pay application indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

### 1.3 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.
    - c. Record data as soon as possible after obtaining it.
    - d. Record and check the markup before enclosing concealed installations.
    - e. Cross-reference record prints to corresponding photographic documentation.
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations.
    - d. Locations and depths of underground utilities.
    - e. Revisions to routing of piping and conduits.
    - f. Revisions to electrical circuitry.
    - g. Actual equipment locations.
    - h. Duct size and routing.
    - i. Locations of concealed internal utilities.
    - j. Changes made by Change Order or Work Change Directive.
    - k. Changes made following Engineer's written orders.
    - l. Details not on the original Contract Drawings.
    - m. Field records for variable and concealed conditions.
    - n. Record information on the Work that is shown only schematically.
  - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
  - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled and annotated OCR.

#### 1.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.
  1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

#### 1.5 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store record documents 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 Engineer's reference during normal working hours. As a prerequisite for monthly progress payments, exhibit the updated record documents for review by Owner and Engineer for accuracy and completeness.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017839





## SECTION 017900 - DEMONSTRATION AND TRAINING

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
- B. Qualification Data: For facilitator and videographer.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within 14 days of end of each training module.
  - 1. Identification: On each copy, provide an applied label with the following information:
    - a. Name of Project.
    - b. Name and address of videographer.
    - c. Name of Engineer.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Date of video recording.
  - 2. At completion of training, submit complete training manual(s) for Owner's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

#### 1.4 QUALITY ASSURANCE

- A. **Facilitator Qualifications:** A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. **Instructor Qualifications:** A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. **Videographer Qualifications:** A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. **Preinstruction Conference:** Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
  - 1. Inspect and discuss locations and other facilities required for instruction.
  - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
  - 3. Review required content of instruction.
  - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

#### 1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Engineer.

#### 1.6 INSTRUCTION PROGRAM

- A. **Program Structure:** Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. **Training Modules:** Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
  - 1. **Documentation:** Review the following items in detail:

- a. Emergency manuals.
  - b. Systems and equipment operation manuals.
  - c. Systems and equipment maintenance manuals.
  - d. Product maintenance manuals.
  - e. Project Record Documents.
  - f. Identification systems.
  - g. Warranties and bonds.
  - h. Maintenance service agreements and similar continuing commitments.
2. Emergencies: Include the following, as applicable:
- a. Instructions on meaning of warnings, trouble indications, and error messages.
  - b. Instructions on stopping.
  - c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside of normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
3. Operations: Include the following, as applicable:
- a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
4. Adjustments: Include the following:
- a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
5. Troubleshooting: Include the following:
- a. Diagnostic instructions.
  - b. Test and inspection procedures.
6. Maintenance: Include the following:
- a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.

- d. Procedures for routine cleaning.
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
7. Repairs: Include the following:
- a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.

## 1.7 PREPARATION

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

## 1.8 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
  - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
  - 3. Owner will furnish Contractor with names and positions of participants.
- B. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- C. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test.
- D. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

## 1.9 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.
  
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode with vibration reduction technology.
  1. Submit video recordings on CD-ROM by uploading to web-based Project software site.
  2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
  3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
  4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:
    - a. Name of Contractor/Installer.
    - b. Business address.
    - c. Business phone number.
    - d. Point of contact.
    - e. Email address.
  
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
  1. Film training session(s) in segments not to exceed 15 minutes.
    - a. Produce segments to present a single significant piece of equipment per segment.
    - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
  
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
  1. Furnish additional portable lighting as required.
  
- E. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017900



## SECTION 018100 - MAINTENANCE OF PLANT OPERATION AND SEQUENCE OF CONSTRUCTION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. The Arlington County Water Pollution Control Plant (WPCP) is operated and staffed 24 hours a day, seven days a week. The existing facility will be maintained in continuous operation by the Owner at all times during the entire construction period, except for periods specifically delineated within this Section. The Contractor shall schedule and conduct his work such that it will not impede any treatment process, create potential hazards to operating equipment and/or personnel, reduce the quality of the plant effluent, disrupt screenings or grit haul operations, disrupt deliveries or cause odor or other nuisance. It shall be the Contractor's responsibility to ensure complete compatibility with the facility operations in his working schedules.

#### 1.3 RELATED WORK

- A. Summary is included in Section 011000.
- B. Construction Progress Documentation is included in Section 013200.
- C. Temporary Facilities and Controls are included in Section 015000.
- D. Execution is included under Section 017300.
- E. Construction Waste Management and Disposal is included under Section 017419.
- F. General Commissioning Requirements is included in Section 019113.
- G. Electrical General Provisions are included in Division 26.
- H. Instrumentation and Control General Provisions are included in Division 40.

#### 1.4 EXISTING PLANT OPERATIONS

- A. The existing treatment plant was designed for an average daily flow of 40 MGD with the capacity to handle a peak hour flow of 88.0 mgd (97.5 mgd through the PTB building including recirculation flows). All temporary bypass pumping systems, if needed, shall be able to pump 97.5 mgd with one pump out of service. Flow produces an approximate average of 460 cubic

ft/day of screenings and grit. This produces an approximate max of 1410 cubic ft/day of screenings and grit.

- B. The Preliminary Treatment Building (PTB) currently has three automatic ½-inch bar screens, each with a design capacity of 50 MGD. This provides for 100 MGD of design capacity with one screen out of service. The plant has a separate Preliminary Influent Backup Structure with two multi-rake bar screens. The operation of the PTB backup structure requires operation of bypass gates which divert flow to the backup structure and manual disposal of screenings collected.
- C. Screenings and grit are currently directed to two haul bins located at opposite ends of the first floor of the PTB. The County has the ability to feed one at a time or both concurrently.
- D. The screenings collected by the existing screens are discharged onto one of two existing shaftless screw conveyors via diverter gates on each screen. The existing shaftless screw conveyors have the ability to operate in forward to feed existing hydraulic ram compactors, which discharge to one of two haul bins on the floor below. The conveyors can also operate in reverse to discharge wet, uncompacted screenings directly into one of the two the haul bins on the floor below. The hydraulic ram compactors have been abandoned by plant operations for which reason the shaftless screw conveyors normally operate in reverse.
- E. Downstream of the screening system, the PTB has four grit trains, each with a design capacity of 30 MGD. Each train has a grit chamber that collects the settled grit. Grit slurry pumps pump the settled grit from the grit chambers to one of two grit classifiers. Each grit classifier discharges grit to a dedicated haul bin on the First Floor.
- F. The facility also collects scum from the primary clarification system. The scum is collected in a scum well located south of the primary clarifiers and can be pumped to the existing scum concentration system in the PTB or to the dissolved air flotation thickeners (DAFT) system at approximately 100 gpm of scum slurry. The existing scum concentration system has been abandoned by plant operations for which reason the scum slurry pumps pump scum slurry to the DAFT system normally.
- G. Influent flow is continuously measured from the three sources feeding the plant.
- H. Seasonal variation in flow is evident with lower than average flows typically experienced in June through October, and highest flow typically experienced in March, April and May. Exceptions can occur at any time.
- I. Unless specifically noted below, or permitted in writing by the Owner and Engineer, the construction activities under this Contract shall not, under any circumstances reduce the treatment capability of the plant. The treatment capability of the plant refers to all portions of wastewater treatment, influent screening and grit removal, primary treatment, secondary treatment, advanced tertiary treatment, chlorination of plant effluent, sludge pumping, dewatering, storage and hauling.
- J. The Owner will continue to operate the treatment plant during the construction period and will be responsible for maintaining effluent quality to comply with the NPDES permit. The Contractor shall fully cooperate with the Owner, coordinate the construction schedule with the Owner and Engineer, and provide the necessary labor, equipment and materials to prevent interruption to flow. The Owner and Engineer reserve the right to modify or expand the schedule during



construction to meet permit limits and prevailing conditions. The Owner may cancel shutdowns at any time due to weather or other operating conditions.

- K. The plant effluent water (PEW) system is located on the southwest corner of the site. Plant effluent water is supplied to wash hose stations, flushing connections, screen channel flushing system, the washer-compactors, and grit classifiers. The water pressure in the system is approximately 40-75 psi.
- L. Foul air at 18,000 cfm is conveyed from the PTB to the South Odor Control System via a 40" foul air RCP that connects to a foul air manhole on the west side of the PTB. A 54" four air RCP conveys odorous air from the manhole to the South Odor Control system. This 54" RCP also collects odorous air from the Primary Gravity Thickener Building, Dissolved Air Flotation Thickener Building, Four Mile Run Lift Station, Four Mile Run Gravity Interceptor Meter Chamber, Sludge Storage Tanks, and Low Level Pump Station. The South Odor Control System operates continuously 24 hours a day, 7 days a week.

#### 1.5 WORK DURING LOW FLOW CONDITIONS

- A. The work specified herein shall be accomplished at such times that will be acceptable or agreed to by the Owner. All construction activity defined herein to be performed during a low flow period shall meet the following criteria. Low influent flow periods are defined as early weekday and weekend mornings (between midnight and 6:00 a.m.), during dry weather periods only. Overtime work by the Contractor to conform to these requirements shall be considered as normal procedure under this Contract, and the Contractor shall make no claim for extra compensation as a result thereof.

#### 1.6 LIMITATIONS ON EXISTING PLANT OPERATIONS AND CONSTRAINTS DURING CONSTRUCTION

- A. The program submitted under Paragraph 1.12 shall be adhered to except where deviations are expressly permitted.
- B. Two of the three influent screen channels must always be in operation and have a functioning screen (new or existing). Only one screen and channel can be taken off-line at a time.
- C. All wastewater samplers and instrumentation required for proper plant operation and reporting shall remain operational throughout construction. Maintain safe access to samplers at all times and coordinate with the Owner and Engineer when access to samplers or sampling will be disrupted or modified. Screen Influent Channel level instrumentation demolition shall be coordinated with new instrumentation installation. One level instrument must remain in service at all times.
- D. Only the Owner's personnel will operate all new and existing valves and equipment as necessary for diverting flow, draining of tanks and channels, etc. to the extent existing systems allow to facilitate construction activities. It is emphasized that the operations of the existing facilities take precedence over all construction activities. Operational assistance given to the Contractor by the Owner will be provided when the Owner's schedule and manpower permit. The timing of such assistance by the Owner may be limited on specific occasions because of process limitations or

unavailability of personnel. Delays caused by such limitations shall be expected and shall not be the basis for claim of extra costs by the Contractor.

- E. All construction-related material removal required as part of the work described herein shall be the responsibility of the Contractor. Wastewater related material in existing channels, screens, conveyors, washer compactors, and scum concentrator shall be removed by the contractor prior to demolition. This material and demolition debris cannot be placed in the County haul bins. Any debris containers stored outside shall remain covered at all times. Malodorous material shall be hauled off-site within 72 hours. Non-odorous material shall be hauled at the Contractor's convenience. Malodorous material to be determined by the Inspector.
- F. The Contractor shall fully cooperate with the Owner and coordinate construction activities to prevent interference or disruption to ongoing wastewater treatment. This includes, but is not limited to, maintaining wastewater treatment while installing new equipment, new instrumentation and control systems, and new electrical service; maintaining site access and traffic patterns; maintaining conveyance systems as required; and completing all demolition, modifications, and new construction activities.
- G. All work connecting with, cutting into, and reconstructing existing pipes or structures shall be planned to minimize the impact on the operation of the existing facilities. The Contractor shall anticipate that these activities may need to be scheduled when the demands on the facilities best permit such interference, even though it may be necessary to work outside of normal working hours to meet these requirements.
- H. Portions of some channels shall remain in service while alterations are being made on other portions. The contractor shall provide all means of isolation to dam-up the channels to create a safe and dry working environment such that two screens and three grit trains can remain in operation at all times. It should be assumed that the County does not have any functional stop-logs that can be used for this. The Contractor may use existing gates and stop log grooves for isolation. The Contractor is responsible for ensuring a safe and dry working environment when using the existing gates.
  - 1. For purposes of installation and removal of temporary flow diversion structures only, a maximum of two screens and two grit trains may be taken offline concurrently for short periods of time (less than 5 days). These shutdowns shall be per the Owner's discretion and shall consider the weather forecast.
  - 2. One screen channel and one grit train can be shut down for a maximum of 50 calendar days at a time.
- I. Portions of some pipelines shall remain in service while alterations are being made on other portions. Piping systems that shall remain in service shall be isolated by placing blind flanges, plugs, or caps on all open ends. Any temporary piping required to keep piping systems in service shall be provided by the Contractor at no additional cost to the Owner. The Contractor is responsible for the stability of all partial piping systems and will provide temporary bracing as required. All wastewater within pipes to be opened shall be collected by the Contractor and discharged into the plant influent system. Wastewater shall not be pumped to nor allowed to flow to the storm drainage system.
- J. Before starting work that will interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all labor, tools, materials, and equipment

are made ready. The Contractor shall also assist in instructing operations and maintenance personnel in any new operating procedures.

- K. The Contractor shall provide, maintain, and operate all temporary facilities such as dams, pumping equipment, conduits, and all other labor and equipment necessary to intercept the sewage flow before it reaches the points where it would interfere with his work, carry it past his work, and return it to the system below his work.
- L. Flow to and through the treatment facility shall not be interrupted. Flow through portions of the plant may only be shut-down to perform work as delineated herein. Any shut-downs shall occur only upon written request and with prior written authorization from the Owner. Such authorizations will be limited to times when the hydraulic capacity of units remaining in service will not be exceeded. When work requires that a portion of the plant be shut down, the Contractor shall be fully prepared to execute the work in the most expeditious manner. The Contractor shall plan the work by taking into consideration all potential problems that may be encountered. Spare pumps, pipe and fittings, and any other equipment appropriate for the work to be done shall be readily available for use in an emergency. The Contractor shall be prepared to work continuously (24 hrs per day, 7 days per week) during the time when any units or pipelines are out of service that affects the ability to meet treatment process capacity, due to unforeseen conditions that were not anticipated when the shut-down was agreed upon.
- M. Given the number of screens available, if bypass pumping of any kind is utilized, sufficient pumping capacity shall be provided to pump 97.5 MGD through or around the existing screening system, with one pump out of service of equal size to the largest pump provided. Screenings removal at ½-inch must be provided at all times during construction.
- N. Screenings from all three existing mechanical screens discharge to one of two common screw conveyors. These conveyors will be replaced. If neither screw conveyor can direct debris to an available screening/grit chute, the Contractor will be responsible for conveying screenings from the online screens to the haul bins on the first floor of the PTB. The haul bins shall remain inside of the PTB at all times with the garage doors closed to maintain odor control, unless being hauled off the plant. Contractor shall coordinate with the Owner and get written permission if haul bins need to be placed outdoors for short periods of time.
  - 1. The Second Floor of the PTB is a composite concrete slab. If temporary equipment is required to convey screenings on the second floor, the point loads should not exceed 100 pounds and shall be spaced a minimum of 24-inches from one another. Contractor shall provide a PE sealed analysis if temporary equipment exceeds the loading specified for approval by the Engineer and Owner.
- O. Grit removal and classification shall remain unaffected and should not be inhibited in any way by the contractor except for planned shut-downs. Only one grit classifier can be shut-down at a time, and only with written approval from the Owner. Temporary shutdown is expected when the grit classifier discharge is modified to combine into the new chutes.
- P. The existing scum concentrator has been abandoned and can be removed at any time during construction. No temporary scum concentrator is required.
- Q. The existing screenings compactors on the second floor can be removed at any time during construction. Temporary compactors are not required.

- R. Plant effluent water (service water) system shall be maintained. If the existing plant water pumping system is disrupted for any reason, protected potable water will need to be substituted via new cross-connections furnished by the Contractor at no additional cost to the Owner. The Contractor will need to provide separate metering for the protected potable water and acquire a hydrant permit from Water Sewer Streets (WSS).
- S. The Contractor shall provide the Owner's personnel and agents with interior and exterior access, including vehicular and personnel access to all areas of the existing facility which remain in operation.
- T. Existing plumbing systems shall be kept in operation at all times. Systems to be removed or replaced shall be kept in operation until new systems have been tested, accepted and authorized for use. If sewers or drains shall be taken out of service to facilitate construction operations, alternative provisions shall be made to collect wastewater or drainage and dispose of them. Such wastewater shall be discharged within the treatment plant as approved by the Owner. Drainage shall be discharged in accordance with the NPDES construction discharge permit.
- U. Unless specified differently, when open tanks and channels are taken offline or put online to accommodate the construction, the Owner will operate the necessary gates and valves to accomplish this work. The Contractor is responsible for removal and disposal of accumulated solids out of the bottom of the tanks and channels and cleaning tanks and channels prior to making modifications. The Contractor is also responsible for the removal of debris accumulated on wet side of temporary flow diversion structures prior to bringing a channel back online.
- V. Electric power and lighting service shall be uninterrupted in all areas that remain in operation except as otherwise specified herein.
- W. All temporary facilities provided by the Contractor shall be demonstrated to be operational to the satisfaction of the Owner before any existing systems can be removed from use. The temporary facilities are critical to the operation of the wastewater treatment facilities. Availability of the facilities shall be maintained at all times. The Contractor shall respond to requests from the Engineer, or designee, for repair and maintenance of temporary facilities with staff on site to address the issue within 60 minutes of notification (7 days per week, 24 hours per day, including holidays). If the Contractor fails to respond to requests for repair and maintenance as noted above, such repair and maintenance may be performed by the Owner. All costs associated with such repair, maintenance, and any other work related to the failure to respond performed by the Owner shall be the responsibility of the Contractor.
- X. New equipment and/or treatment units may not be placed in-service until specified testing and acceptance procedures are completed and written authorization for use is given by the Engineer.
- Y. Contractor staging and parking areas have been designated on Drawing C-1 along with areas for temporary offices for the Engineer. The Contractor shall make all arrangements necessary to secure additional offsite parking and staging areas as required throughout the duration of construction.
  - 1. Crane use must be coordinated with OWNER one week in advance. Crane can remain in place for up to 72 hours before having to be relocated off-site or to the staging area. Every effort must be taken to maximize OWNER access to PTB for haul bin removal and general operations.

- Z. All plant access roads shall remain unobstructed throughout Construction for staff use, sludge hauling, truck deliveries, chemical deliveries, and any other purpose required by plant activities.
- AA. Work in the screen channels will be confined space entry.
- BB. For purposes of modification to the existing foul air manhole adjacent to the PTB, the manhole may be depressurized for up to 72 hours. This shutdown must be coordinated minimum two weeks in advance with the owner. The plugging of the 40" RCP will be completed on the first day and the remainder of the 72 hours will be cure time before repressurizing the manhole. The owner will be responsible for bypassing all upstream sources of odorous air and will be responsible for operation of the South Odor Control system in order to depressurize the manhole.
- CC. County combustible gas detection (CGD) monitoring equipment must be maintained throughout construction for work inside of Class I Division 1 areas. Any condition within 10% of LEL will require the contractor to provide temporary ventilation systems such that the condition no longer exists.
- DD. Any welding or hot work inside of classified areas must comply with NFPA 820, Section 10.11.3 and WPCB contractor safety standards.
- EE. Contractor shall install new exhaust fan PTB-EF-10 in the PTB during construction to provide appropriate ventilation throughout construction per NFPA 820 and OSHA prior to demolishing existing foul air fans. Fan shall operate continuously (24 hours a day/7 days a week).
- FF. Existing wall mounted louvers will provide make-up air. Remove any panels covering the louvers prior to operating the PTB-EF-10. New motor operated dampers will be provided at the louvers as shown on the drawings. These should be locked in the open during construction.
- GG. Once the new odor control and make-up air systems are installed and operations, PTB-EF-10 shall operate per the requirements shown on the drawings.
- HH. Contractor shall maintain PTB temperature above 45 degrees Fahrenheit throughout construction.

## 1.7 SEQUENCING CONSTRAINTS

- A. In order to assist the Contractor in developing a sequence of construction required under Paragraph 1.12 Submittals, a list of constraints is presented.
- B. Electrical Systems.
  - 1. Existing Bar Screen Control Panel cannot be demolished until respective new bar screens are installed and operational.
- C. SCADA Controls.
  - 1. All instrumentation and controls shall be loop tested and accepted prior to respective equipment startup.

2. Terminations of existing screen panels shall be disabled as each new corresponding screen and panel is installed.
  - a. Contractor will coordinate with County staff prior to work in existing panels.

D. Operational.

1. Construction activities shall not commence on the second screening system until the 30-day acceptance period is met on the first new screening system. Construction activities shall not commence on the third screening system until the 7-day acceptance period is met for the second new screening system.
2. One new mechanical bar screen connected to a new or existing screw conveyor capable of delivering screenings to the haul bins on the first floor shall be fully operational before taking another mechanical bar screen off-line. Subsequently, two new mechanical bar screens connected to a new or existing screw conveyor capable of delivering screenings to the haul bins on the first floor shall be fully operational before taking the final bar screen off-line for replacement.

## 1.8 SEQUENCE OF CONSTRUCTION - GENERAL

- A. In order to maintain continuous plant operation during construction, a phased construction sequence similar to that described herein shall be required. Specific constraints and steps are outlined, and are intended to suggest a sequence for specific activities. This sequence shall be coordinated with the Owner and the Engineer and submitted for approval in accordance with the requirements of Paragraph 1.12. Work shall not commence unless the sequence has been approved.
- B. The detailed sequence of construction shall be based upon the schedule submitted by the Contractor and approved by the Engineer as specified above. However, as a guide for bidders in the preparation of their bid and for the Contractor in the preparation of his schedule, a suggested sequence of construction is described below. The Contractor may alter the sequence as approved by the Engineer, providing plant operations are maintained.
- C. The order of construction shall be subject to the approval of the Engineer; such approval or direction, however, shall in no way relieve the Contractor's responsibility to perform the work in strict accordance with the Contract Documents. The construction plans and specifications have been developed to minimize the construction impacts on the operation of the treatment plant. The Contractor shall note the requirements of this Section with regard to the operation of the plant and the phasing of construction when developing his work sequence. The Contractor's work sequence shall be specifically detailed in the schedule that is required under Construction Progress Documentation in Section 013200.
- D. The following work sequence provides for completing the construction of the project within the requirements of the Owner's plant operation and scheduling limitations. It does not purport to cover all sequences necessitated by the actual construction methods. This is a partial outline only. Portions of the work not specifically itemized shall be scheduled by the Contractor in accordance with the requirements of the approved construction sequence. The Contractor is required to account for all details in formulating his own complete plan for implementation of the project.

- E. The actual start and completion of the tasks as described below may overlap one another in performance of the work. Numerical identification of the stages does not necessarily conform to the actual order of construction.

## 1.9 PROPOSED SEQUENCE OF CONSTRUCTION – SPECIFIC AREAS

### A. Preliminary Treatment Building

1. Ventilation improvements shall be coordinated during colder temperature periods of the year. Contractor shall make their best effort to limit the use of EF-11 to the months of October through April.
2. Demolish existing hydraulic ram compactors and seal connection point on existing shaftless screw conveyors.
3. Demolish existing scum concentration system. New scum concentration system and ancillary components can be installed at any point during construction.
4. PEW, COW, HOT PEW systems shall remain active with minimal shutdowns. Upgrades can be made at any point during construction, in coordination with the Owner. COW and HOT PEW shut downs shall be limited to 4-hours at a time with written approval from the Owner 48 hours in advance of the shutdown.
5. Isolate Screen Channel 1 and the Northwest Grit train.
  - a. The Screen Influent and Effluent Gates, Influent Stop Log Guides, Grit Channel Gates and E-W Grit Channel Isolation Stop Log Guides may be used for the installation of a temporary flow diversion structure and for isolation. The Owner does not have stop logs available for use by the Contractor.
6. Drain and Clean Screen Channel 1.
7. Demolish existing Screen 1, Screen 1 Influent Gate Actuator, Screen 1 Drain Gate Valve, Screen 1 Effluent Gates and Screen 1 Diverter Gate.
8. Install new Screen 1 Effluent Gates, Screen 1 Influent Gate Actuator, Screen 1 Drain Gate Valve, modify pocket at base of channel for new screen and conduct all other ancillary upgrades for the screens.
9. Coat channel.
10. Install new Screen 1.
11. Provide temporary conveyance for screenings from Screen 1 to existing screw conveyors or haul bins.
12. Functional and performance testing for Screen 1.
13. 30 Day Acceptance Period for Screen 1.
14. Isolate Screen Channel 3 and the Northeast Grit train.
  - a. The Screen Influent and Effluent Gates, Influent Stop Log Guides, Grit Channel Gates and E-W Grit Channel Isolation Stop Log Guides may be used for the installation of a temporary flow diversion structure and for isolation. The Owner does not have stop logs available for use by the Contractor.
15. Drain and Clean Screen Channel 3.
16. Demolish existing Screen 3, Screen 3 Influent Gate Actuator, Screen 3 Drain Gate Valve, Screen 3 Effluent Gates and Screen 3 Diverter Gate.
17. Install new Screen 3 Effluent Gates, Screen 3 Influent Gate Actuator, Screen 3 Drain Gate Valve, modify pocket at base of channel for new screen and conduct all other ancillary upgrades for the screens.

18. Coat channel.
19. Install new Screen 3.
20. Provide temporary conveyance for Screen 3 to existing screw conveyors or haul bins.
21. Functional and performance testing for Screen 3.
22. 7 Day Acceptance Period for Screen 3.
23. Demolish existing shaftless screw conveyors and chutes. Contractor to convey screenings and grit to haul bins until new shaftless screw conveyors, washer-compactors, and chutes are installed.
24. Modify second floor composite slab for new chutes. Chutes may be modified simultaneously or consecutively.
25. Install new chutes, shaftless screw conveyors and washer-compactors.
26. Conduct functional, performance, and acceptance testing on this equipment.
27. Isolate Screen Channel 2 from all grit trains.
  - a. The Screen Influent and Effluent Gates, Influent Stop Log Guides, Grit Channel Gates and E-W Grit Channel Isolation Stop Log Guides may be used for the installation of a temporary flow diversion structure and for isolation. The Owner does not have stop logs available for use by the Contractor.
28. Drain and Clean Screen Channel 2.
29. Demolish existing Screen 2, Screen 2 Influent Gate Actuator, Screen 2 Drain Gate Valve, Screen 2 Effluent Gates and Screen 2 Diverter Gate.
30. Install new Screen 2 Effluent Gates, Screen 2 Influent Gate Actuator, Screen 2 Drain Gate Valve, modify pocket at base of channel for new screen and conduct all other ancillary upgrades for the screens.
31. Coat channel.
32. Install new Screen 2.
33. Functional and performance testing for Screen 2.
34. 7 Day Acceptance Period for Screen 2.
35. 30 Day System Acceptance Period.

B. Ventilation and explosive gas detection systems must be maintained throughout construction.

#### 1.10 ACCEPTANCE

- A. Refer to respective equipment specifications for acceptance requirements.
- B. System Acceptance: In addition to individual equipment acceptance requirements, there shall be a 30-day system acceptance period for all equipment to operate as a system continuously. The complete system includes the bar screens, screw conveyors, washer/compactors, associated gates, associated controls, and debris chutes. Contractor shall be on-call and on-site within 24-hour notice, as needed during the system acceptance period.

#### 1.11 RELATED DOCUMENTS

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

#### 1.12 ACTION SUBMITTALS



- A. The Contractor shall at all times conduct operations so as not to interfere with existing works. The Contractor shall develop a sequence of operation, in cooperation with the Engineer and Owner, which shall provide for the construction and start-up of the new works without requiring any shut-down of existing operations. Any interference with the existing facilities and processes shall be clearly identified in the sequence of operation developed including reasons why the interference cannot be avoided. Alternative sequences shall be presented, including the reasons why the alternative sequence does not avoid the interference to the plant's operation.
- B. Within 60 calendar days of the Notice to Proceed, the Contractor shall submit, in accordance with the provisions of Section 013200, complete descriptions of procedures to maintain plant operation to supplement the construction schedule developed in accordance with Division 1. The description shall include:
  - 1. Step-by-step procedures, required durations, and specific procedures required to be performed by the Contractor as well as assistance from the Owner's personnel that the Contractor will request. The procedures shall include a minimum two week notification to the Owner for any alterations that affect operation of the treatment facility.
  - 2. Step-by-step procedures for connecting new equipment to the existing SCADA system. Refer to sections 406121.10 Process Control System Testing and 406100 Process Control and Enterprise Management Systems General Provisions.
  - 3. Complete plans of temporary systems required as part of this Contract to maintain plant operations. These plans shall clearly delineate the intended location of these items and the Contractor's proposed methods for phasing from existing to temporary to completed facilities.
  - 4. All connections to existing systems, including coordination activities performed by Contractor and Owner personnel.

### 1.13 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sequence of Construction showing installation of screens and gates, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Screening Equipment
  - 2. Gates
  - 3. Screw Conveyors
  - 4. Washer Compactor
  - 5. Scum Concentrator
- B. Include construction details, material descriptions, dimensions of individual components and profiles for temporary equipment and facilities. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Provide plans, elevations, sections, and attachment details with locations, dimensions, weights, loads, required clearances, and diagrams for power, signal, and control wiring as necessary.
- C. Contractor to develop work safety plan in accordance with NFPA and OSHA limits for explosive gasses, H<sub>2</sub>S and any other potential OSHA identified workplace hazards.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 018100

## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. General requirements for coordinating and scheduling commissioning activities.
2. Commissioning meetings.
3. Commissioning reports.
4. Use of commissioning process test equipment, instrumentation, and tools.
5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
6. Commissioning tests and commissioning test demonstration.
7. Adjusting, verifying, and documenting identified systems and assemblies.

##### B. Related Requirements:

1. Section 011000 "Summary" for Commissioning Authority responsibilities.
2. Section 011200 "Multiple Contract Summary" for Commissioning Authority responsibilities.
3. Section 013300 "Submittal Procedures" for submittal procedure requirements for commissioning process.
4. Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
5. Section 017823 "Operation and Maintenance Data" for preliminary operation and maintenance data submittal requirements.
6. Section 260800 "Commissioning of Electrical Systems" for technical commissioning requirements for electrical systems.
7. Section 280800 "Commissioning of Electronic Safety and Security" for technical commissioning requirements for electronic safety and security systems.

#### 1.2 DEFINITIONS

- A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- B. Basis-of-Design Document: A document prepared by Engineer that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.
- C. Commissioning Authority: An entity engaged by Owner to evaluate Commissioning-Process Work.

- D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.
- E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with Owner's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities. The scope of the commissioning process is defined in Section 011000 "Summary."
- F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished. Owner will establish in writing the date construction-phase commissioning-process completion is achieved. See Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
  - 1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:
    - a. Completion of tests and acceptance of test results.
    - b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
    - c. Comply with requirements in Section 017900 "Demonstration and Training."
    - d. Completion and acceptance of submittals and reports.
  - 2. Commissioning process to be executed in phases in coordination with Section 018100 "Maintenance of Plant Operations".
- G. Owner's Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Owner or for the Owner by the Engineer or Commissioning Authority.
- H. Owner's Witness: Commissioning Authority, Owner's Project Manager, or Engineer-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.
- I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- K. Sampling Procedures and Tables for Inspection by Attributes: As defined in ASQ Z1.4.

### 1.3 COMPENSATION

- A. If Engineer, Commissioning Authority, other Owner's witness, or Owner's staff perform additional services or incur additional expenses due to actions of Contractor listed below, compensate Owner for such additional services and expenses.
  - 1. Failure to provide timely notice of commissioning activities schedule changes.
  - 2. Failure to meet acceptance criteria for test demonstrations.
- B. Contractor shall compensate Owner for such additional services and expenses at the rate of \$167.00 per labor hour, plus the cost of airfare and/or mileage to personal vehicles per round trip for personnel travelling more than 200 miles, plus per diem allowances for meals and lodging according to current U.S. General Services Administration (GSA) Per Diem Rates.

### 1.4 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s):
  - 1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
  - 2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.
  - 3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a particular portion of the commissioning process.
  - 4. Appointed team members shall have the authority to act on behalf of the entity they represent.
- B. Members Appointed by Owner:
  - 1. Commissioning Authority, plus consultants that Commissioning Authority may deem appropriate for a particular portion of the commissioning process.
  - 2. Owner representative(s), facility operations and maintenance personnel, plus other employees, separate contractors, and consultants that Owner may deem appropriate for a particular portion of the commissioning process.
  - 3. Engineer, plus employees and consultants that Engineer may deem appropriate for a particular portion of the commissioning process.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Comply with requirements in Section 013300 "Submittal Procedures" for submittal procedure general requirements for commissioning process.
- B. Commissioning Plan Information:
  - 1. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors performing the various commissioning requirements.
  - 2. Schedule of commissioning activities, integrated with the Construction Schedule. Comply with requirements in Section 013200 "Construction Progress Documentation" for the Construction Schedule general requirements for commissioning process.

3. Contractor personnel and subcontractors participating in each test.
  4. List of instrumentation required for each test to include identification of parties that will provide instrumentation for each test.
- C. Commissioning schedule.
- D. Two-week look-ahead schedules.
- E. Commissioning Coordinator Letter of Authority:
1. Within 10 days after approval of Commissioning Coordinator qualifications, submit a letter of authority for Commissioning Coordinator, signed by a principal of Contractor's firm. Letter shall authorize Commissioning Coordinator to do the following:
    - a. Make inspections required for commissioning process.
    - b. Coordinate, schedule, and manage commissioning process of Contractor, subcontractors, and suppliers.
    - c. Obtain documentation required for commissioning process from Contractor, subcontractors, and suppliers.
    - d. Report issues, delayed resolution of issues, schedule conflicts, and lack of cooperation or expertise on the part of members of the commissioning team.
- F. Commissioning Coordinator Qualification Data: For entity coordinating Contractor's commissioning activities to demonstrate their capabilities and experience.
1. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- G. List test instrumentation, equipment, and monitoring devices. Include the following information:
1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
  2. Brief description of intended use.
  3. Calibration record showing the following:
    - a. Calibration agency, including name and contact information.
    - b. Last date of calibration.
    - c. Range of values for which calibration is valid.
    - d. Certification of accuracy.
    - e. Certification for calibration equipment traceable to NIST.
    - f. Due date of the next calibration.
- H. Test Reports:
1. Pre-Startup Report: Prior to startup of equipment or a system, submit signed, completed construction checklists.
  2. Test Data Reports: At the end of each day in which tests are conducted, submit test data for tests performed.

3. Commissioning Issue Reports: Daily, at the end of each day in which tests are conducted, submit commissioning issue reports for tests for which acceptable results were not achieved.
4. Weekly Progress Report: Weekly, at the end of each week in which tests are conducted, submit a progress report.
5. Data Trend Logs: Submit data trend logs at the end of the trend log period.
6. System Alarm Logs: Daily, at the start of days following a day in which tests were performed, submit printout of log of alarms that occurred since the last log was printed.

I. Construction Checklists:

1. Material checks.
2. Installation checks.
3. Startup procedures, where required.

1.6 CLOSEOUT SUBMITTALS

A. Commissioning Report:

1. At Construction-Phase Commissioning Completion, include the following:
  - a. Pre-startup reports.
  - b. Approved test procedures.
  - c. Test data forms, completed and signed.
  - d. Progress reports.
  - e. Commissioning issue report log.
  - f. Commissioning issue reports showing resolution of issues.
  - g. Correspondence or other documents related to resolution of issues.
  - h. Other reports required by commissioning process.
  - i. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
  - j. Report shall include commissioning work of Contractor.

B. Request for Certificate of Construction-Phase Commissioning Process Completion.

C. Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Calibration Agency Qualifications: Certified by The American Association for Laboratory Accreditation that the calibration agency complies with minimum requirements of ISO/IEC 17025.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Test equipment and instrumentation required to perform the commissioning process shall remain the property of Contractor unless otherwise indicated.
- B. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:
  - 1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
  - 2. Calibrated and certified.
    - a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever is more frequent, but not less than within six months of initial use on Project. Calibration tags shall be permanently affixed.
    - b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.
  - 3. Maintain test equipment and instrumentation.
  - 4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

### 2.2 PROPRIETARY TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate, or perform work on its equipment.
  - 1. Identify proprietary test equipment, instrumentation, and tools required in the test equipment identification list submittal.
  - 2. Proprietary test equipment, instrumentation, and tools shall become the property of Owner at Substantial Completion.

### 2.3 REPORT FORMAT AND ORGANIZATION

- A. General Format and Organization:
  - 1. Bind report in three-ring binders.
  - 2. Label the front cover and spine of each binder with the report title, volume number, project name, Contractor's name, and date of report.
  - 3. Record report on compact disk.



4. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.

B. Commissioning Report:

1. Include a table of contents and an index to each test.
2. Include major tabs for each Specification Section.
3. Include minor tabs for each test.
4. Within each minor tab, include the following:
  - a. Test specification.
  - b. Pre-startup reports.
  - c. Approved test procedures.
  - d. Test data forms, completed and signed.
  - e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation related to resolution of issues for each test repetition together within the minor tab, in reverse chronological order (most recent on top).

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Review preliminary construction checklists and preliminary test procedures and data forms.

### 3.2 CONSTRUCTION CHECKLISTS

- A. Construction checklists cannot modify or conflict with the Contract Documents.
- B. Create construction checklists based on actual systems and equipment to be included in Project.
- C. Material Checks: Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.
  1. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
  2. Included optional features.
  3. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.
  4. Installation Checks:
    - a. Location according to Drawings and approved Shop Drawings.
    - b. Configuration.
    - c. Compliance with manufacturers' written installation instructions.
    - d. Attachment to structure.

- e. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
  - f. Utility connections are of the correct characteristics, as applicable.
  - g. Correct labeling and identification.
  - h. Startup Checks: Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.
- D. Startup: Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.
- E. Performance Tests:
1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.
  2. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
  3. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
  4. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
  5. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.
- F. Deferred Construction Checklists: Obtain Owner approval of proposed deferral of construction checklists, including proposed schedule of completion of each deferred construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, deferred construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
1. Identify deferred construction checklists by number and title.
  2. Provide a target schedule for completion of deferred construction checklists.
  3. Written approval of proposed deferred construction checklists, including approved schedule of completion of each deferred construction checklist.
- G. Delayed Construction Checklists: Obtain Owner approval of proposed delayed construction checklists, including proposed schedule of completion of each delayed construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, delayed construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
1. Identify delayed construction checklist by construction checklist number and title.
  2. Provide a target schedule for completion of delayed construction checklists.
  3. Written approval of proposed delayed construction checklists, including approved schedule of completion of each delayed construction checklist.

### 3.3 GENERAL EXECUTION REQUIREMENTS

- A. Schedule and coordinate commissioning process with the Construction Schedule.
- B. Perform activities identified in construction checklists, including tests, and document results of actions as construction proceeds.
- C. Perform test demonstrations for Owner's witness. Unless otherwise indicated, demonstrate tests for 100 percent of work to which the test applies. In some instances, demonstration of a random sample of other than 100 percent of the results of a test is specified.
  - 1. Where sampling is specified, the sampling plan and procedure for the test demonstration shall be as described in Division 40.
- D. Report test data and commissioning issue resolutions.
- E. Schedule personnel to participate in and perform Commissioning-Process Work.
- F. Installing contractors' commissioning responsibilities include, but are not limited to, the following:
  - 1. Operating the equipment and systems they install during tests.
  - 2. In addition, installing contractors may be required to assist in tests of equipment and systems with which their work interfaces.

### 3.4 COMMISSIONING COORDINATOR RESPONSIBILITIES

- A. Management and Coordination: Manage, schedule, and coordinate commissioning process, including, but not limited to, the following:
  - 1. Coordinate with subcontractors on their commissioning responsibilities and activities.
  - 2. Obtain, assemble, and submit commissioning documentation.
  - 3. Attend periodic on-site commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."
  - 4. Develop and maintain the commissioning schedule. Integrate commissioning schedule into the Construction Schedule. Update Construction Schedule at specified intervals.
  - 5. Review and comment on preliminary test procedures and data forms.
  - 6. Report inconsistencies and issues in system operations.
  - 7. Verify that tests have been completed and results comply with acceptance criteria, and that equipment and systems are ready before scheduling test demonstrations.
  - 8. Direct and coordinate test demonstrations.
  - 9. Coordinate witnessing of test demonstrations by Owner's witness.
  - 10. Coordinate and manage training. Be present during training sessions to direct video recording, present training, and direct the training presentations of others. Comply with requirements in Section 017900 "Demonstration and Training."
  - 11. Prepare and submit specified commissioning reports.
  - 12. Track commissioning issues until resolution and retesting is successfully completed.
  - 13. Retain original records of Commissioning-Process Work, organized as required for the commissioning report. Provide Owner's representative access to these records on request.
  - 14. Assemble and submit commissioning report.

### 3.5 COMMISSIONING TESTING

- A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.
- B. Owner's witness will be present to witness commissioning work requiring the signature of an owner's witness, including, but not limited to, test demonstrations. Owner's project manager will coordinate attendance by Owner's witness with Contractor's published Commissioning Schedule. Owner's witness will provide no labor or materials in the commissioning work. The only function of Owner's witness will be to observe and comment on the progress and results of commissioning process.
- C. Construction Checklists:
  - 1. Complete construction checklists as Work is completed.
  - 2. Distribute construction checklists to installing contractors before they start work.
  - 3. Installers:
    - a. Verify installation using approved construction checklists as Work proceeds.
    - b. Complete and sign construction checklists weekly for work performed during the preceding week
  - 4. Provide Commissioning Authority access to construction checklists.
- D. Installation Compliance Issues: Record as an installation compliance issue Work found to be incomplete, inaccessible, at variance with the Contract Documents, nonfunctional, or that does not comply with construction checklists. Record installation compliance issues on the construction checklist at the time they are identified. Record corrective action and how future Work should be modified before signing off the construction checklist.
- E. Pre-Startup Audit: Prior to executing startup procedures, review completed installation checks to determine readiness for startup and operation. Report conditions, which, if left uncorrected, adversely impact the ability of systems or equipment to operate satisfactorily or to comply with acceptance criteria. Prepare pre-startup report for each system.
- F. Test Procedures and Test Data Forms:
  - 1. Test procedures shall define the step-by-step procedures to be used to execute tests and test demonstrations.
  - 2. Test procedures shall be specific to the make, model, and application of the equipment and systems being tested.
  - 3. Completed test data forms are the official records of the test results.
  - 4. Commissioning Authority will provide to Contractor preliminary test procedures and test data forms for performance tests and commissioning tests after approval of Product Data, Shop Drawings, and preliminary operation and maintenance manual.
  - 5. Review preliminary test procedures and test data forms, and provide comments within 14 days of receipt from Commissioning Authority. Review shall address the following:

- a. Equipment protection and warranty issues, including, but not limited to, manufacturers' installation and startup recommendations, and operation and maintenance instructions.
  - b. Applicability of the procedure to the specific software, equipment, and systems approved for installation.
6. After Contractor has reviewed and commented on the preliminary test procedures and test data forms, Commissioning Authority will revise and reissue the approved revised test procedures and test data forms marked "Approved for Testing."
  7. Use only approved test procedures and test data forms marked "Approved for Testing" to perform and document tests and test demonstrations.

G. Performance of Tests:

1. The sampling rate for tests is 100 percent. The sampling rate for test demonstrations is 100 percent unless otherwise indicated.
2. Perform and complete each step of the approved test procedures in the order listed.
3. Record data observed during performance of tests on approved data forms at the time of test performance and when the results are observed.
4. Record test results that are not within the range of acceptable results on commissioning issue report forms in addition to recording the results on approved test procedures and data forms according to the "Commissioning Compliance Issues" Paragraph in this Article.
5. On completion of a test, sign the completed test procedure and data form. Tests for which test procedures and data forms are incomplete, not signed, or which indicate performance that does not comply with acceptance criteria will be rejected. Tests for which test procedures and data forms are rejected shall be repeated and results resubmitted.

H. Performance of Test Demonstration:

1. Perform test demonstrations on a sample of tests after test data submittals are approved. The sampling rate for test demonstrations shall be 100percent unless otherwise indicated in the individual test specification.
2. Notify Owner's witness at least two weeks in advance of each test demonstration.
3. Perform and complete each step of the approved test procedures in the order listed.
4. Record data observed during performance of test demonstrations on approved data forms at the time of demonstration and when the results are observed.
5. Provide full access to Owner's witness to directly observe the performance of all aspects of system response during the test demonstration. On completion of a test demonstration, sign the completed data form and obtain signature of Owner's witness at the time of the test to authenticate the reported results.
6. Test demonstration data forms not signed by Contractor and Owner's witness at the time of the completion of the procedure will be rejected. Test demonstrations for which data forms are rejected shall be repeated and results shall be resubmitted.
  - a. Exception for Failure of Owner's Witness to Attend: Failure of Owner's witness to be present for agreed-on schedule of test demonstration shall not delay Contractor. If Owner's witness fails to attend a scheduled test, Contractor shall proceed with the scheduled test. On completion, Contractor shall sign the data form for Contractor and for Owner's witness, and shall note the absence of Owner's witness at the scheduled time and place.

7. False load test requirements are specified in related sections.
  - a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Engineer's written approval.

I. Deferred Tests:

1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved, deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:
  - a. Identify deferred tests by number and title.
  - b. Provide a target schedule for completion of deferred tests.
2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Engineer and Commissioning Authority at least ten working days (minimum) in advance of tests.
3. Where deferred tests are specified, coordinate participation of necessary personnel and of Engineer, Commissioning Authority, and Owner's witness. Schedule deferred tests to minimize occupant and facility impact. Obtain Engineer's approval of the proposed schedule.

J. Delayed Tests:

1. Delayed Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed delayed tests. Obtain Owner approval of proposed delayed tests, including proposed schedule of completion of each delayed test, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. Include the following in the request for Certificate of Construction-Phase Commissioning Process Completion:
  - a. Identify delayed tests by test number and title.
  - b. Written approval of proposed delayed tests, including approved schedule of completion of delayed tests.
2. Schedule and coordinate delayed tests. Schedule delayed tests when conditions that caused the delay have been rectified. Notify Engineer and Commissioning Authority at least ten working days (minimum) in advance of tests, unless otherwise approved by Engineer and Owner.
3. Where delayed tests are approved, coordinate participation of necessary personnel and of Engineer, Commissioning Authority, and Owner's witness. Schedule delayed tests to minimize occupant and facility impact. Obtain Engineer's approval of the proposed schedule.

K. Commissioning Compliance Issues:

1. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
3. If a test demonstration fails, determine the cause of failure. Direct timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials, reimburse Owner for billed costs for the participation in the repeated demonstration.
4. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:
  - a. Complete a commissioning compliance issue report form promptly on discovery of test results that do not comply with acceptance criteria.
  - b. Submit commissioning compliance issue report form within 24 hours of the test.
  - c. Determine the cause of the failure.
  - d. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.
5. Commissioning Compliance Issue Report: Provide a commissioning compliance issue report for each issue. Do not report multiple issues on the same commissioning compliance issue report.
  - a. Exception: If an entire class of devices is determined to exhibit the identical issue, they may be reported on a single commissioning compliance issue report. (For example, if all return-air damper actuators that are specified to fail to the open position are found to fail to the closed position, they may be reported on a single commissioning issue report. If a single commissioning issue report is used for multiple commissioning compliance issues, each device shall be identified in the report, and the total number of devices at issue shall be identified.
  - b. Complete and submit Part 1 of the commissioning compliance issue report immediately when the condition is observed.
  - c. Record the commissioning compliance issue report number and describe the deficient condition on the data form.
  - d. Resolve commissioning compliance issues promptly. Complete and submit Part 2 of the commissioning compliance issue report when issues are resolved.
6. Diagnose and correct failed test demonstrations as follows:
  - a. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
  - b. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
  - c. Record the results of each step of the diagnostic procedure.
  - d. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
  - e. Determine and record corrective measures.
  - f. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.

7. Retest:
  - a. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Obtain signature of Owner's witness on retest data forms. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Owner for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
  - b. For each repeated test demonstration, submit a new test data form, marked "Retest."
8. Do not correct commissioning compliance issues during test demonstrations.
  - a. Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed at the discretion of the Engineer. If corrections are made under this exception, note the deficient conditions on the test data form and issue a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

### 3.6 COMMISSIONING MEETINGS

- A. Schedule and conduct commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."

### 3.7 SEQUENCING

- A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:
  1. Construction Checklists:
    - a. Material checks.
    - b. Installation checks.
    - c. Startup, as appropriate. Some startup may depend on component performance. Such startup may follow component performance tests on which the startup depends.
    - d. Performance Tests:
      - 1) Static tests, as appropriate.
      - 2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
      - 3) Equipment and assembly performance tests.
      - 4) System performance tests.
      - 5) Intersystem performance tests.
  2. Commissioning tests.



- B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to construction checklists.
- C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Engineer if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.
- D. Commence tests as soon as installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.

### 3.8 SCHEDULING

- A. Commence commissioning process as early in the construction period as possible.
- B. Commissioning Schedule: Integrate commissioning activities into Construction Schedule. See Section 013200 "Construction Progress Documentation."
  - 1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
  - 2. Schedule the start date and duration for the following commissioning activities:
    - a. Submittals.
    - b. Preliminary operation and maintenance manual submittals.
    - c. Installation checks.
    - d. Startup, where required.
    - e. Performance tests.
    - f. Performance test demonstrations.
    - g. Commissioning tests.
    - h. Commissioning test demonstrations.
  - 3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.
  - 4. Determine milestones and prerequisites for commissioning process. Show commissioning milestones, prerequisites, and dependencies in monthly updated critical-path-method construction schedule and short-interval schedule submittals.
- C. Two-Week Look-Ahead Commissioning Schedule:
  - 1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
  - 2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
  - 3. Use two-week look-ahead schedules to notify and coordinate participation of Owner's witnesses.
- D. Owner's Witness Coordination:

1. Coordinate Owner's witness participation via Engineer.
2. Notify Engineer of commissioning schedule changes at least five work days in advance for activities requiring the participation of Owner's witness.

### 3.9 COMMISSIONING REPORTS

#### A. Test Reports:

1. Pre-startup reports include observations of the conditions of installation, organized into the following sections:
  - a. Equipment Model Verification: Compare contract requirements, approved submittals, and provided equipment. Note inconsistencies.
  - b. Preinstallation Physical Condition Checks: Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.
  - c. Preinstallation Component Verification Checks: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
  - d. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
  - e. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Owner completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.
2. Test data reports include the following:
  - a. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
  - b. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
  - c. Signatures of individuals performing and witnessing tests.
  - d. Data trend logs accumulated overnight from the previous day of testing.
3. Commissioning Compliance Issue Reports: Report as commissioning compliance issues results of tests and test demonstrations that do not comply with acceptance criteria. Report only one issue per commissioning compliance issue report. Use sequentially numbered facsimiles of commissioning compliance issue report form included in this Section, or other form approved by Owner. Distribute commissioning compliance issue reports to parties responsible for taking corrective action. Identify the following:
  - a. Commissioning compliance issue report number. Assign unique, sequential numbers to individual commissioning compliance issue reports when they are created, to be used for tracking.

- b. Action distribution list.
  - c. Report date.
  - d. Test number and description.
  - e. Equipment identification and location.
  - f. Briefly describe observations about the performance associated with failure to achieve acceptable results. Identify the cause of failure if apparent.
  - g. Diagnostic procedure or plan to determine the cause (include in initial submittal)
  - h. Diagnosis of fundamental cause of issues as specified below (include in resubmittal).
  - i. Fundamental cause of unacceptable performance as determined by diagnostic tests and activities.
  - j. When issues have been resolved, update and resubmit the commissioning issue report forms by completing Part 2. Identify resolution taken and the dates and initials of the persons making the entries.
  - k. Schedule for retesting.
4. Weekly progress reports include information for tests conducted since the preceding report and the following:
- a. Completed data forms.
  - b. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
  - c. Activities scheduled but not conducted per schedule.
  - d. Commissioning compliance issue report log.
  - e. Schedule changes for remaining Commissioning-Process Work, if any.
5. Data trend logs shall be initiated and running prior to the time scheduled for the test demonstration.
- a. Trend log data format shall be multiple data series graphs. Where multiple data series are trend logged concurrently, present the data on a common horizontal time axis. Individual data series may be presented on a segmented vertical axis to avoid interference of one data series with another, and to accommodate different axis scale values. Graphs shall be sufficiently clear to interpret data within the accuracy required by the acceptance criteria.
  - b. Attach to the data form printed trend log data collected during the test or test demonstration.
  - c. Record, print out, and attach to the data form operator activity during the time the trend log is running. During the time the trend log is running, operator intervention not directed by the test procedure invalidates the test results.
6. System Alarm Logs: Record and print out a log of alarms that occurred since the last log was printed. Evaluate alarms to determine if the previous day's work resulted in any conditions that are not considered "normal operation."
- a. Conditions that are not considered "normal operation" shall be reported on a commissioning issue report attached to the alarm log. Resolve as necessary. The intent of this requirement is to discover control system points or sequences left in manual or disabled conditions, equipment left disconnected, set points left with abnormal values, or similar conditions that may have resulted from failure to fully restore systems to normal, automatic control after test completion.

3.10 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

- A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Owner agrees to accept separately, is complete, Contractor shall prepare and submit to Owner and Commissioning Authority through Engineer a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to complete commissioning process.
- B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case, Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.
- C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Engineer's and Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.
- D. When construction-phase commissioning process or designated portion is complete, Commissioning Authority will prepare a Certificate of Construction-Phase Commissioning Process Completion that shall establish the date of completion of construction-phase commissioning process. Certificate of Construction-Phase Commissioning Process Completion shall be submitted prior to requesting inspection for determining date of Substantial Completion.

END OF SECTION 019113

## SECTION 024119 - SELECTIVE DEMOLITION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Demolition and removal of selected portions of building or structure.
- B. Related Requirements:
  - 1. Section 017300 "Execution" for cutting and patching procedures.

#### 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove Hazardous Materials: Isolate and remove hazardous materials from existing construction and properly dispose as required by existing regulations.
- C. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; dispose of items.

#### 1.4 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
  - 1. Inspect and discuss condition of construction to be selectively demolished.
  - 2. Review structural load limitations of existing structure.
  - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review areas where existing construction is to remain and requires protection.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Documentation of Existing Conditions: Submit photographic or video documentation of the existing condition of building.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property for environmental protection. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure on-site operations are uninterrupted.
  - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
  - 4. Use of elevator and stairs.
  - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations.
- E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

## 1.6 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

## 1.7 FIELD CONDITIONS

- A. Owner will occupy all portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. Hazardous materials will be removed by Owner before start of the Work.
  - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.

- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  - 1. Maintain fire-protection facilities in service during selective demolition operations.

## 1.8 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing conditions provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Document Existing Conditions: Record existing conditions by use of preconstruction photographs or video.
  - 1. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

### 3.3 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  1. Provide protection to ensure safe passage of people around selective demolition area.
  2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  4. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  5. Maintain fire watch during and for at least 3 hours after flame-cutting operations.
  6. Maintain adequate ventilation when using cutting torches.



7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

### 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

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

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
1. Do not allow demolished materials to accumulate on-site.
  2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
  4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

### 3.7 CLEANING

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

END OF SECTION 024119



## SECTION 030100.61 - CONCRETE REPAIRS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes concrete repair consisting of the following:

1. Removal of existing concrete.
2. Bonding new concrete.
3. Repair mortar.
4. Crack and leaking construction joint repair (polyurethane chemical grout injection).
5. Crack repair (epoxy adhesive injection).
6. Spalled, deteriorated, and disintegrated concrete repair.
7. Sealing of joints between existing and new concrete.

- B. Related Requirements:

1. Section 024119 "Selective Demolition" for partial removal of various building components and systems.
2. Section 033000 "Cast-in-Place Concrete" for ground and elevated cast concrete.
3. Section 030130.71 "Modifications to Existing Concrete" for modifying existing concrete.
4. Section 050519 "Post-Installed Anchors" for testing of drilled in injection adhesive anchor system.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Including manufacturers printed performance criteria, product life, working time after mixing, surface preparation and application requirements and procedures, curing, and volatile organic compound data.
2. Storage requirements including temperature, humidity, and ventilation.
3. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for:
  - a. Polyurethane chemical grout.
  - b. Crack repair epoxy adhesive.
  - c. Epoxy bonding agent.
  - d. Adhesive anchor system.
  - e. Repair mortars.
  - f. Backer rods.

g. Epoxy adhesive paste.

4. Include rated capacities, operating characteristics, and accessories.

#### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Product Certificates: Notarized certificate for each repair material stating that product meets requirements of this Section and has manufacturer's current printed literature on product package or container.

#### 1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company with a minimum of 10 years' documented experience and having an ongoing program to train, certify, and technically support installers.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. Contractor's Supervisor: Having attended a training program sponsored by manufacturer supplying project approved materials.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Deliver materials in original, new, and unopened packages and containers clearly labeled with information referenced in Division 01 and the following information:

1. Manufacturer's stock number and batch number.
2. Date of manufacture.
3. Expiration or use-by date.

B. Storage of Materials:

1. Store only approved materials on site.

#### 1.7 FIELD CONDITIONS

A. Conform to temperatures and other environmental factors as stated within manufacturer's published installation instructions for storage, substrate conditions, application, curing, and other procedures required by work of this Section.

#### 1.8 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer and Installer agree to repair or replace products that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SYSTEM PERFORMANCE

- A. Use materials in compliance with state and local regulations.

### 2.2 MATERIALS

#### A. Polyurethane Chemical Grout:

1. Single component, expanding, moisture reactive polyurethane grout designed to seal cracks and open joints in concrete. Provide cured chemical grout that forms a compressed closed cell urethane foam that completely fills the crack or joint.
2. Accelerator: May be used if recommended by approved polyurethane chemical grout manufacturer.
3. Provide injection packers for application of polyurethane chemical grout.
4. Acceptable Manufacturers and Products: Provide one of the following or equal:
  - a. BASF Corporation: Concrevice 1210 IUG.
  - b. Sika Corporation: SikaFix HH.
  - c. W. R. Grace & Co.: HA Multigel NF, by De Neef.

#### B. Crack Repair Epoxy Adhesive:

1. ASTM C881/ C881M, Type V, Grade 2, Class C; two-component, solvent-free, moisture insensitive epoxy resin material suitable for repairing cracks in concrete by injection or gravity feed; formulated for specific size of opening or crack being injected.
2. Acceptable Manufacturers and Products: Provide one of the following or equal:
  - a. Euclid Chemical Company: EUCO #452.
  - b. Five Star Products Inc.: Bonding Adhesive.
  - c. Sika Corporation: Sikadur 32, Hi Mod.

#### C. Epoxy Bonding Agent:

1. Two-component, solvent-free, asbestos-free moisture insensitive epoxy resin material used to bind plastic concrete to hardened concrete and complying with requirements of ASTM C881, Type V, Grade 2, Class C.
2. Acceptable Manufacturers and Products: Provide one of the following or equal:
  - a. Euclid Chemical Company: Dural 452 MV.
  - b. Sika Corporation: Sikadur 32, Hi Mod.
  - c. Simpson Strong-Tie Company Inc.: FX-762.

- D. Adhesive Anchor System: A system utilizing an injection adhesive manufactured for installation of drilled-in reinforcing steel dowels.

1. Injection Adhesive: Two-component epoxy system including a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep both components separate. Provide side-by-side cartridges designed to accept a static mixing nozzle which thoroughly blends both components and allows injection directly into a drilled hole.
  2. Acceptable Manufacturers and Products: Provide one of the following or equal:
    - a. Hilti: HIT-RE 500-SD; referenced as Basis-of-Design materials, unless otherwise noted.
    - b. Redhead: G5.
    - c. Simpson Strong: Tie Epoxy SET-XP.
- E. Horizontal Repair Mortars - Polymer-Modified Portland Cement Mortar:
1. Two-component polymer-modified, portland cement-based mortar used to repair horizontal surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 7,000 psiat 28 days tested in accordance with ASTM C881 or ASTM C109.
  2. Acceptable Manufacturers and Products: Provide one of the following or equal:
    - a. BASF Corporation: MasterEmaco T 310CI.
    - b. Euclid Chemical Company: DuralTop Flowable Mortar.
    - c. Sika Corporation: SikaTop 122 Plus.
- F. Vertical and Overhead Repair Mortars - Polymer-Modified Portland Cement Mortar:
1. Two-component polymer-modified, portland cement based, fast setting, non-sag mortar used to repair vertical and overhead surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 5,000 psiat 28 days tested in accordance with ASTM C881 or ASTM C109.
  2. Acceptable Manufacturers and Products: Provide one of the following or equal:
    - a. Euclid Chemical Company: DuralTop Gel.
    - b. Sika Corporation: SikaTop 123 Plus.
    - c. US MIX Company: US SPEC H2.
- G. Epoxy Paste Adhesive:
1. Two-component, solvent-free, moisture insensitive epoxy resin material used as an adhesive for mating surfaces where the glue line is 1/8 inch or less and to bond fresh, plastic concrete to clean, sound hardened concrete and complying with requirements of ASTM C881, Type IV, Grade 3, Class C.
  2. Test Data: Base test upon material and curing condition of 73 plus/minus two degrees F and 50 plus/minus five percent Relative Humidity.
  3. Acceptable Manufacturers and Products: Provide one of the following or equal:
    - a. Sika Corporation: Sikadur 31 Hi-Mod Gel.
    - b. Euclid Chemical Company: Dural 452 Gel.
    - c. BASF Corporation: MasterEmaco ADH 1420.

## 2.3 ACCESSORY MATERIALS

### A. Backer Rods:

1. Open Cell Backer Rod: Extruded, open cell polyurethane foam. Diameter shall not be less than 200 percent of the joint width dimension.
2. Closed Cell Backer Rod: Extruded, non-staining, resilient closed cell polyethylene foam, compatible with sealant. Diameter shall not be less than 25 percent greater than the joint width. Sealant shall not adhere to backer rod.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions with Installer present, for compliance with requirements for maximum moisture content and installation tolerances affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Manufacturer's Representative: Be present for first three days of installation to give instructions to installation crew and then make periodic site visits to ensure products are being installed in accordance with published instructions.

### 3.3 GENERAL

- A. Store, mix, apply, and cure materials for each repair system in strict compliance with manufacturer's installation instructions. Make repairs necessary, without additional compensation, so completed work complies with Contract Document work scopes.
- B. Where concrete is repaired near an expansion joint or control joint, preserve isolation between components on either side of the joint.
- C. Identify reinforcing locations prior to drilling using reinforcing bar locators so that drill hole locations may be adjusted to avoid reinforcing interference. When drilling holes for dowels and bolts, stop drilling if reinforcing is encountered. Relocate hole to avoid reinforcing as approved by the Engineer. Do not cut reinforcing without prior approval by the Engineer.
- D. Concrete designated to be removed to specific limits indicated or directed by the Engineer, shall be done by saw cutting 3/4 inch deep at limits of removal followed by line drilling, chipping, sandblasting, or airblasting, as appropriate in areas where deteriorated, damaged, or unsound concrete is to be removed. Remove concrete such that surrounding concrete and existing reinforcing to be left in place and existing in place equipment are not damaged.
  1. Perform full thickness saw-cutting at limits of concrete to be removed only if indicated, specified, or after obtaining written approval from the Engineer.

- E. Saw-cut edges straight for vertically and horizontally repair areas. Make intersecting cuts perpendicular to each other.
  - F. Stop saw cutting if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Identify reinforcing locations within one foot of saw cut locations in any direction prior to saw cutting using reinforcing bar locators.
  - G. Clean concrete surfaces of efflorescence, deteriorated concrete, dirt, laitance, and existing repair materials such as liners, adhesives, and epoxies. Remove foreign matter and deleterious films by sandblasting, airblasting, scarifying or other mechanical means to sound original concrete.
  - H. Thoroughly clean repair area with oil-free compressed air, then install bonding agent. Place repair materials within open time of epoxy bonding agent.
  - I. Consolidate repair material, completely filling all portions of area to be filled.
  - J. Bring finished repair surfaces into alignment with adjacent existing surfaces to provide a uniform, flush, and even surface. Match repair surfaces to adjacent existing surfaces in texture, including any coatings or surface treatments that had been provided for existing surface.
  - K. Remove excess material from faces of materials being repaired and adjacent walls, floors, and slabs. Leave exposed faces of surface materials clean and ready to accept subsequent work.
  - L. Repair or replace concrete indicated or specified to be left in place, but that is damaged because of the work of this Section. Perform work by approved means and methods.
- 3.4 CRACK AND CONSTRUCTION JOINT REPAIR (POLYURETHANE CHEMICAL GROUT INJECTION REPAIR TYPE "A")
- A. Apply polyurethane chemical grout to leaking cracks, joints, and voids in existing concrete.
  - B. Install polyurethane chemical grout through drilled-in injection ports installed as recommended by polyurethane chemical grout manufacturer. Install and cure polyurethane repair materials in accordance with manufacturer's requirements.
  - C. Remove injection ports and seal with grout. Leave repair area flush with surrounding concrete surfaces.
- 3.5 CRACK REPAIR (EPOXY ADHESIVE INJECTION REPAIR TYPE "B")
- A. Repair cracks on horizontal surfaces by gravity feeding crack repair epoxy adhesive into cracks. Pressure inject cracks less than 1/16 inch in thickness.
  - B. Repair cracks on vertical surfaces by pressure injecting crack repair epoxy adhesive through injection ports sealed to surface with crack repair epoxy adhesive.
  - C. Clean cracks by sandblasting, water jet, or high-pressure oil free air to remove loose matter, dirt, laitance, oil, grease or other contaminants. Prior to injection of the crack apply a surface seal of epoxy paste to crack faces.



1. Establish openings in surface seal (injection ports) along the crack. Do not allow distance between injection ports to be greater than slab or wall thickness.
2. Begin injection at first port at one end of the crack. For vertical or inclined surfaces begin injection at lowest point of the crack. Continue injection at first port until injected epoxy begins to flow out of second port in line.
3. Plug first port and continue injection from second port. Inject entire crack following same sequence. Continue injecting crack and do not stop until crack is completely injected.
4. After injected epoxy has cured, remove or cut off ports and grind flush with adjacent concrete surface. Do not allow indentations or protrusions caused by port placements.

### 3.6 SPALLED/DETERIORATED CONCRETE REPAIR (REPAIRS TYPE "C", "E", AND "F")

- A. Only use polymer-modified cementitious repair mortar for surface repair of spalled or deteriorated concrete.
- B. Comply with manufacturer's recommendations for concrete removal, surface preparation, mixing, application, lift thickness, finishing, moist curing, and form removal.
- C. Saw cut perimeter of deteriorated concrete to form a rectangle with straight edges to depth indicated. Remove fractured, loose, broken, softened, and deteriorated concrete by abrasive blasting, chipping, or other appropriate means to sound concrete. Chip concrete substrate to obtain a surface profile with a new fractured aggregate surface.
- D. Remove dirt, oil, grease, and other bond inhibiting materials from surface by dry mechanical means such as sand blasting, chipping, or wire brushing. Thoroughly clean surface of loose or weakened material and dust by dry mechanical means such as oil-free air blast. Follow recommendations of repair mortar manufacturer for additional surface preparation.
- E. Do not damage reinforcing steel that is to be incorporated into new concrete. Where reinforcing steel with active corrosion is encountered, use following procedure:
  1. Use dry mechanical means to remove loose material, contaminants and rust from exposed reinforcing steel.
  2. When more than half of reinforcing bar diameter is exposed, chip out behind reinforcing steel, 1 inch minimum.
  3. Make distance chipped behind a reinforcing bar equal to or exceed minimum placement depth of material being used, 1 inch minimum.
  4. If existing reinforcing steel has lost more than 15 percent of its original cross-sectional area, splice in new reinforcing as shown on Drawings.
- F. Repair cracks encountered in substrate area of spalled or deteriorated concrete repair as specified directed by the Engineer.
- G. Repair Mortar Placement:
  1. Follow procedures recommended by manufacturer for mixing and placement of repair mortar.
  2. After initial mixing of repair mortar, do not add water to change the consistency, should the mix begin to stiffen.
  3. Saturate substrate surface dry (SSD) with no standing water during application.

4. Apply scrub coat to substrate, filling all pores and voids.
5. While scrub coat is still plastic, apply polymer-modified repair mortar. Place repair mortar to an even, uniform plane to restore the member to its original surface.
6. For applications greater than 1 inch depth, apply repair mortar in lifts. Score exposed surface of each lift to produce a roughened surface before applying the next lift. Allow lift to reach final set before proceeding with subsequent lift.

H. Finishing:

1. Apply repair mortar with a smooth, steel trowel finish, unless otherwise noted.
2. Have no sharp edges when repair is completed. Make exterior corners, such as at penetrations, with a 1 inch radius. Make interior corners square.

I. Curing: Perform as recommended by repair mortar manufacturer, except that cure period shall be at least 24 hours and done by means of a continuous fog spray or moist cure with wet burlap.

J. Repairs Requiring Formwork:

1. Remove fractured, loose, deteriorated, and unsound concrete by bush hammering, chipping, high pressure water blast, or other appropriate dry mechanical means. Remove dirt, oil, grease, and other bond inhibiting materials from concrete surface.
2. Treat existing anchor bolts, exposed reinforcing steel, and reinforcing to be incorporated into repair mortar, as specified below.
3. Construct leakproof forms as required by project conditions. Line or coat forms with release agents recommended by repair mortar manufacturer. Provide forms of adequate strength, securely anchored in place and shored to resist the forces imposed by repair mortar and its placement.
4. Saturate existing concrete surfaces with water, with no standing water during application. Prime concrete surface with a scrub coat of repair mortar. Restore area to original limits or as shown using repair mortar before scrub coat dries. Extend repair mortar with 3/8 inch aggregate only as recommended by manufacturer of repair mortar.

### 3.7 FIELD QUALITY CONTROL

- A. At completion of repairs, Contractor, Engineer, and material Installer shall meet to inspect installed work. Repair leaking joints, cracks, or voids in accordance with manufacturer's instructions. Contractor, Engineer, and Installer shall reinspect repaired problem areas. Make subsequent repairs until work is in conformance with Contract Documents.
- B. Crack Repair Epoxy Adhesive: The Engineer may take random 2-inch-diameter core samples for visual inspection and strength testing to verify adequacy of repairs.
- C. Prepare inspection reports.

END OF SECTION 030100.61

## SECTION 030130.71 - MODIFICATIONS TO EXISTING CONCRETE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes:

- 1. Cutting, removing, or modifying parts of existing concrete structures or appurtenances.
- 2. Addressing existing steel reinforcing bars encountered.
- 3. Bonding new concrete or grout to existing concrete.

- B. Related Requirements:

- 1. Section 024119 "Selective Demolition" for selective demolition and modification procedures.
- 2. Section 030100.61 "Concrete Repairs" for repair materials and related repair work.
- 3. Section 033000 "Cast-In-Place Concrete" for concrete materials, and related work.
- 4. Section 036000 "Grouting" for grout and related accessories.
- 5. Section 050519 "Post-Installed Anchors" for anchors and related accessories.
- 6. Section 055000 "Metal Fabrications" for various metals and related fabrications.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site .

- 1. Review methods and procedures related to modifications to existing concrete including, but not limited to, the following:
  - a. Verify specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
  - b. Materials, material application, sequencing, tolerances, and required clearances.
  - c. Quality-control program.
  - d. Coordination with building occupants.
- 2. Attendees:
  - a. Owner.
  - b. Resident Engineer.
  - c. Contractor.
  - d. Engineer.

#### 1.4 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

1. Submit manufacturer's technical literature and installation instructions that include:
  - a. Current printed recommendations and product data sheets for products including performance criteria, product life, working time after mixing, surface preparation and application requirements and procedures, curing, volatile organic compound data, and safety requirements.
  - b. Storage requirements including temperature, humidity, and ventilation.

#### 1.5 INFORMATIONAL SUBMITTALS

##### A. Qualification Data: Documentation of the qualifications for Contractor qualifications, Manufacturer's qualifications, and Contractor's supervisor as specified in Paragraph 1.6.

##### B. Material Certificates: For each material provided.

#### 1.6 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Have a minimum of ten years' experience within last 10 years in manufacture and use of specified products and have an ongoing program of training, certifying, and technically supporting Contractor's personnel.
- B. **Contractor Qualifications:** Complete a program of instruction in application of approved manufacturer's material and provide certification from manufacturer attesting to their training and status as an approved applicator.
- C. **Contractor's Supervisor:** Have attended a training program sponsored by manufacturer supplying materials approved for this project.
- D. **Manufacturer's Representative:** Make periodic site visits as needed to ensure products being installed are in accordance with published instructions.
- E. Do not shift, cut, remove, or otherwise altered existing structure or concrete until authorization is given by the Engineer.
- F. When removing materials from or making openings in existing structures, take precautions and erect necessary barriers, shoring and bracing, and other protective devices. Prevent damage to structures beyond limits necessary for new work, protect personnel, control dust, and to prevent damage to structures or contents by falling or flying debris.
- G. Unless otherwise permitted, shown, or specified, cut existing concrete by line drilling.
- H. **Construction Tolerances:** Comply with requirements specified elsewhere in Division 03, except as modified herein, and elsewhere in Contract Documents.
- I. Make locations and phases of the work available for access by the Engineer or other personnel designated by the Engineer. Provide ventilation and safe access to the work.

- J. Be solely responsible for workmanship and quality of modification work. Inspections by the manufacturer, the Engineer, or others do not limit Contractor's responsibility for work quality.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials in original, new and unopened packages and containers clearly labeled with the following information:
  - 1. Manufacturer's name.
  - 2. Name or title of material, and other product identification.
  - 3. Manufacturer's stock number and batch number.
  - 4. Date of manufacture.
  - 5. Instructions.
  - 6. Expiration date.
- B. Storage: Store products in accordance with manufacturers' published recommendations and the following supplementary requirements:
  - 1. Store only approved materials on site and in locations as directed.
  - 2. Keep area clean and accessible.
  - 3. Comply with health and fire regulations including those of the Occupational Safety and Health Administration (OSHA).
- C. Handling: Handle products carefully and in accordance with manufacturers' published recommendations and the following supplementary requirements:
  - 1. Prevent inclusion of foreign materials.
  - 2. Do not open containers or mix components until necessary preparatory work has been completed and application work will start immediately.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Comply with this Section and applicable state and local regulations.
- B. Epoxy Bonding Agent:
  - 1. Product: Two-component, solvent-free, asbestos-free moisture insensitive epoxy resin material used to bind plastic concrete to hardened concrete and complying with requirements of ASTM C881, Type V, Grade 2, Class C.
- C. Epoxy Paste Adhesive:
  - 1. Product: Two-component, solvent-free, moisture insensitive epoxy resin material used as an adhesive for mating surfaces where the glue line is 1/8 inch or less and to bond fresh, plastic concrete to clean, sound hardened concrete and complying with requirements of ASTM C881, Type IV, Grade 3, Class C.

- D. Repair Mortar (Polymer-Modified Portland Cement Mortar):
1. Horizontal Surfaces:
    - a. Product: Two-component polymer-modified, portland cement based mortar used to repair horizontal surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 7,000 psi at 28 days tested in accordance with ASTM C881 or ASTM C109.
  2. Vertical and Overhead Surfaces:
    - a. Product: Two-component polymer-modified, portland cement based, fast setting, non-sag mortar used to repair vertical and overhead surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 5,000 psi at 28 days tested in accordance with ASTM C881 or ASTM C109.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION - GENERAL

- A. Cut, remove, or otherwise modify parts of existing structures or appurtenances as indicated, specified, or as necessary to complete the work. Finishes, joints, reinforcements, sealants, and similar materials are specified in their respective Sections. Install work complying with requirements of this Section and as indicated.
- B. Locations, details, and limits of modifications are indicated on Drawings. Comply with requirements of this Section and as indicated on Drawings.
- C. Examine areas and conditions under which modification work is to be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
- D. Store, mix, apply, and cure materials in strict compliance with manufacturer's instructions.
- E. Where concrete is to be modified near an expansion joint or control joint, preserve isolation between components on either side of the joint.
- F. When drilling holes for dowels and bolts, stop drilling if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Relocate hole to avoid reinforcing as approved by the Engineer.

1. Identify reinforcing locations prior to drilling using reinforcing bar locators so that drill hole locations may be adjusted to avoid reinforcing interference.
- G. Saw-cut edges for modification areas vertically and horizontally straight. Make intersecting cuts perpendicular to each other.
- H. Stop saw cutting if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Identify reinforcing locations within 1 foot of saw cut locations in any direction prior to saw cutting using reinforcing bar locators.
- I. Clean concrete surfaces of efflorescence, deteriorated concrete, dirt, laitance, and existing repair materials such as liners, adhesives, and epoxies. Remove foreign matter and deleterious films by sandblasting, oil-free air-blasting, scarifying, or other mechanical means to sound original concrete.
- J. Consolidate modification materials, completely filling portions of the area to be filled.
- K. Bring finished surfaces into alignment with adjacent existing surfaces to provide a uniform, flush, and even surface. Match repair surfaces to adjacent existing surfaces in texture including any coatings or surface treatments that had been provided for the existing structure.
- L. Repair or replace concrete indicated or specified to be left in place that is damaged because of the work by approved means without additional compensation.

### 3.3 CONCRETE REMOVAL

- A. Concrete designated to be removed to specific limits indicated or directed by the Engineer, perform saw cutting 1 inch deep at limits of removal followed by line drilling and chipping, sandblasting, or oil-free airblasting, as appropriate in the areas where concrete is to be taken out. Remove concrete such that surrounding concrete and existing reinforcing to be left in place and existing in place equipment are not damaged.
  1. Perform full thickness saw-cutting at limits of concrete to be removed only if indicated, herein specified, or after obtaining written approval from the Engineer.
- B. Where existing reinforcing is exposed due to saw cutting or line drilling and no new material is to be placed on cut surface, apply a 1/4 inch thick surface treatment of epoxy paste to entire cut surface. Where cut reinforcing is perpendicular to cut concrete surface, grid/cut the reinforcing bar back to 1/2 inch below the concrete surface. Coat the end of the bar with epoxy adhesive.
- C. Where joint between new concrete or grout and existing concrete will be exposed in finished work, remove concrete edge by making a 1 inch deep saw cut on each exposed surface of existing concrete or as indicated.

### 3.4 CONNECTION SURFACE PREPARATION

- A. Concrete areas requiring patching, repairs, or modifications, prepare connection surfaces as specified, as indicated, or as directed by the Engineer.

- B. Remove loose and deteriorated materials, efflorescence, existing repair materials, dirt, oil, grease, and other bond inhibiting materials from concrete surface by dry mechanical means such as sandblasting, chipping, wire brushing, or other mechanical means as approved by the Engineer.
  - 1. Uniformly roughen concrete surface to approximately 1/4 inch amplitude with pointed chipping tools. Thoroughly clean surface of loose or weakened material by sandblasting or air-blasting.
  - 2. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete.
- C. If reinforcing steel is exposed, mechanically clean to remove loose material, contaminants, and rust as approved by the Engineer. If half of reinforcing steel diameter is exposed, chip out behind the steel. Chip distance behind the steel to a minimum of 1 inch. Do not damage reinforcing to be incorporated in new concrete or repair mortar during removal operation.
- D. Clean reinforcing from existing removed or deteriorated concrete that is shown to be incorporated in new concrete or repair mortar by mechanical means to remove loose material and products of corrosion before proceeding. Cut, bend, or lap to new reinforcing as indicated and provide with 1 inch minimum clear cover.
- E. Use following specific concrete surface preparation Methods where indicated, specified, or as directed by the Engineer:
  - 1. Method A:
    - a. Roughen and clean existing concrete surface at connection.
    - b. Thoroughly saturate surfaces with water; prevent standing water during application.
    - c. Scrub repair mortar into substrate filling concrete pores and voids.
    - d. While scrub coat is still plastic, force repair material against surface. Use epoxy bonding agent if area is too large.
    - e. Place new repair mortar as detailed.
  - 2. Method B:
    - a. Roughen and clean existing concrete surface at connection.
    - b. Apply epoxy bonding agent at connection surfaces.
    - c. Place new concrete or grout mixture to limits indicated within time constraints recommended by manufacturer to ensure bond.
  - 3. Method C:
    - a. Use adhesive anchoring system, as specified in Section 050519 "Post-Installed Anchors", for installation of reinforcing steel dowels into existing concrete where indicated.
    - b. Perform installation complying strictly with manufacturer's recommendations, including drill bit diameter, surface preparation, injection, and installation of dowels.
    - c. Drill concrete to embedded deformed bars to indicated depths.



- d. Use oil-free compressed air to blast out loose particles and dust from drilled holes. Clean dowels to be free of dirt, oil, grease, ice, or other deleterious material that would reduce bond.
  - e. Concrete in existing structures is considered to have a strength of 3,000 psi.
4. Method D:
- a. Combination of Method B & Method C.

### 3.5 GROUTING

- A. Grout: As specified in Section 036000 "Grouting."

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed installations.
  - 1. Perform inspection with Contractor, material installer, and the Engineer present. Give minimum of 72 hours' notice prior to time of inspection.
  - 2. Repair modifications not in conformance with Contract Documents in accordance with manufacturer's instructions at no additional cost to Owner.
  - 3. At completion of non-conforming repairs, Contractor, material installer, and the Engineer shall reinspect the repaired problem areas.
  - 4. Prepare inspection reports, identifying acceptable work, type and locations of unacceptable work, and actions taken to correct unacceptable work.
  - 5. Complete field quality control work without additional compensation.

END OF SECTION 030130.71



## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
  - 1. Section 036000 "Grouting" for grouting.

#### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials change, source of cement or aggregate change or test results do not meet specification requirements, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, spacing, lengths, material, grade, bar schedules, bent bar diagrams, bar arrangement, splices and laps, tie spacing, hoop spacing, and supports for concrete reinforcement. Reference bars to be the same identification marks shown on the bar bending details.
- D. Material Certificates: For each of the following:
  - 1. Cementitious materials.
  - 2. Admixtures.

3. Steel reinforcement and accessories.
4. Curing compounds.
5. Bonding agents.
6. Repair materials.

E. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
2. Mill Test Reports:
  - a. Cementitious materials.
  - b. Steel Reinforcing.

### 1.5 INFORMATIONAL SUBMITTALS

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- B. Field quality-control reports.
- C. PE Certification form for the design of formwork and shoring.

### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
  2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

### 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Provide reinforcement free from mill scale, rust, mud, dirt, grease, oil, ice, or other foreign matter that will reduce or destroy bond. Deliver, store, and handle steel reinforcement to prevent bending and damage. Store reinforcement off the ground, protect from moisture, and keep out of standing water, and free from rust, mud, dirt, grease, oil, ice, or other contaminants and deleterious films that will reduce or destroy bond.

## 1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301.
  2. ACI 117.
  3. ACI 318.

### 2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Plywood, metal, or other approved panel materials.

2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
  - a. Structural 1, B-B or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
  1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties: Factory-fabricated, removable or snap-off metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
  3. Furnish ties with integral water-barrier plates to below grade walls.

### 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

### 2.4 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- B. Tie wires for reinforcement: 16 gauge or heavier black annealed wire to tie uncoated reinforcing. Use zinc coated wire to tie galvanized reinforcing. Use epoxy coated wire to tie epoxy coated reinforcing.

### 2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type II.
  2. Fly Ash: ASTM C618, Class F.
  3. Slag Cement: ASTM C989/C989M, Grade 120.
- C. Normal-Weight Aggregates: ASTM C33/C33M, coarse aggregate or better, graded. Provide aggregates from a single source.
1. Maximum Coarse-Aggregate Size: ASTM C33 Size Number 67 nominal.
  2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
- F. Water: ASTM C94/C94M and potable.

## 2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1-D, Class B, dissipating.

## 2.7 RELATED MATERIALS

- A. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.8 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.

2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
  2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109/C109M.

## 2.9 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.
  2. Slag Cement: 45 percent.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture in concrete, for placement and workability.

## 2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Drilled Shaft Foundations - Non-Tremie: Normal-weight concrete.
1. Minimum Compressive Strength: 4000 psi at 28 days.
  2. Maximum W/C Ratio: 0.45.
  3. Slump Limit: 5 inches , plus or minus 1 inch.
  4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.
- B. Drilled Shaft Foundations - Tremie: Normal-weight concrete.
1. Minimum Compressive Strength: 4000 psi at 28 days.



2. Maximum W/C Ratio: 0.40.
3. Slump Limit: 7 inches, plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.
5. Include anti-washout agent.

C. Other than Drilled Shafts: Normal-weight concrete.

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery

## 2.11 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
1. Class A, 1/8 inch for smooth-formed finished surfaces.
  2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight to prevent loss of concrete mortar.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Install reglets, recesses, and the like, for easy removal.

2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, ice, snow and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 EMBEDDED ITEM INSTALLATION

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for walls, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

### 3.4 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
  - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

### 3.5 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose mill scale, rust, mud, dirt, grease, oil, ice, and other foreign materials that reduce or destroy the bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Splicing:
  - 1. If not indicated on Drawings, locate reinforcement splices at point of minimum stress.

### 3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
  - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
  - 2. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  - 3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  - 4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  - 5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces. Intentionally roughen concrete surface and remove laitance prior to applying epoxy-bonding adhesive.
  - 6. At construction joints and at concrete joints indicated on Drawings to be "roughened", uniformly roughen the surface of concrete to a full amplitude (distance between high and low points and side to side) of 1/4 inch with chipping tools to expose a fresh face.

Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to consistency of very heavy paste. Coat surfaces to a depth of at least 1/8 inch thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.

7. Do not use keyways in construction joints unless specifically shown on the Drawings or approved by the Engineer.

### 3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid "cold" joints.
  2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  4. Slope surfaces uniformly to drains where required.
  5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

### 3.8 FINISHING FORMED SURFACES

- A. Finish concrete surfaces according to ACI 318.

- B. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.9 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
- C. Broom Finish: Apply a broom finish to exterior concrete platforms, landings, steps, ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

### 3.10 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Pads:
  - 1. Coordinate sizes and locations of concrete pads with actual equipment provided.
  - 2. Minimum Compressive Strength: 4000 psi at 28 days.
  - 3. Install reinforcing dowels; to connect concrete pad to concrete floor. Unless otherwise indicated.
  - 4. For supported equipment, install anchor bolts that extend through concrete pad and anchor into structural concrete substrate.
  - 5. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

6. Cast anchor-bolt insert into pads. Install anchor bolts to elevations required for proper attachment to supported equipment.

### 3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.
  3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

- a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

### 3.12 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit sawcut at the perimeter of the area to a depth of 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

### 3.13 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Notify the Owner when the reinforcing is complete and ready for inspection, at least six working hours prior to the proposed concrete placement. Do not cover reinforcing steel with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been inspected by the Owner's inspection agency and the Owner's inspection agency's release to proceed with the concreting has been obtained. Keep forms open until the Owner's inspection agency has completed inspection of the reinforcement.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements by the Owner's testing agency:
1. Testing Frequency: One composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
  2. Testing Frequency: One composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests will be performed when concrete consistency appears to change.
  4. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.



5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.
  - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
  - b. Cast and field cure sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
  - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
  - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi
11. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Engineer.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033000



## SECTION 036000 - GROUTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Portland cement grout.
2. Nonshrink epoxy grout.
3. Nonshrink cementitious grout.

- B. Related Requirements:

1. Section 024119 "Selective Demolition" for demolition and removals.
2. Section 033000 "Cast-in-Place Concrete."
3. Section 051200 "Structural Steel" for grout related to structural framing members.
4. Section 055000 "Metal Fabrications" for grout related to miscellaneous metals.

#### 1.3 ACTION SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.

- B. Product Data: Submit manufacturer information regarding grout and surface preparation, mixing and installation.

1. Commercially manufactured nonshrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
2. Commercially manufactured nonshrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
3. Cement grout. Include the type and brand of cement, the gradation of fine aggregate, product data on any proposed admixtures and the proposed grout mix.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- B. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.

- C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- D. Qualifications Statement:
  - 1. Submit qualifications for grout manufacturer.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience in production and use of provided grouts.
- B. Pre-installation Meeting: At least ten working days before grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Notify all parties involved with grouting, including the Engineer, of the meeting at least ten working days prior to its scheduled date.
- C. Services of Manufacturer's Representative: Provide services of a field technician of the nonshrink grout manufacturer who has performed at least five projects of similar size and complexity during the last five years, to attend the pre-installation meeting, to be present for the initial installation of each type of nonshrink grout, and to correct installation problems.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.
- D. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.
- E. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location.
  - 2. Provide additional protection according to manufacturer instructions.

#### 1.7 AMBIENT CONDITIONS

- A. Section 015000 "Temporary Facilities and Controls" for requirements for ambient condition control facilities for product storage and installation.
- B. Maximum Conditions: Do not perform grouting if temperatures exceed 90 degrees F.

- C. Minimum Conditions: Do not perform grouting if the minimum temperature of base plates, supporting concrete and grout are less than 40 degrees F. Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

## PART 2 - PRODUCTS

### 2.1 PORTLAND CEMENT GROUT

- A. Portland Cement: Comply with ASTM C150/C150M, Type I and II.
- B. Water:
  - 1. Potable.
  - 2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:
    - a. Corrosion of steel.
    - b. Volume change increasing shrinkage cracking.
    - c. Efflorescence.
    - d. Excess air entraining.
- C. Fine Aggregate:
  - 1. Washed natural sand.
  - 2. Gradation:
    - a. Comply with ASTM C33/C33M.
    - b. Represented by smooth granulometric curve within required limits.
  - 3. Free from injurious amounts of organic impurities according to ASTM C40/C40M.
- D. Mix:
  - 1. Portland cement, sand, and water.
  - 2. Do not use ferrous aggregate or staining ingredients in grout mixes.

### 2.2 NONSHRINK EPOXY GROUT

- A. Description:
  - 1. Pre-proportioned, prepackaged, three-component, nonshrink epoxy grout, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate.
- B. Performance and Design Criteria:
  - 1. Minimum Compressive Strength:
    - a. 10,000 psi at seven days.
    - b. Comply with ASTM D695.

2. Coefficient of Expansion:
  - a.  $30 \times 10^{-6}$  inch per degree F.
  - b. Comply with ASTM C531.
3. Minimum Tensile Strength:
  - a. 1,800 psi.
  - b. Comply with ASTM C307.

C. Product: Provide one of the following:

1. Masterflow 648 CP; by BASF Building Systems.
2. Five Star HP Epoxy Grout; by Five Stars Products, Inc.
3. Sikadur 42 Grout-Pak; by Sika Corp.
4. E3-G Epoxy Grout; by Euclid Chemical Co.
5. Or equal.

## 2.3 NONSHRINK CEMENTITIOUS GROUT

A. Description:

1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, not containing expansive cement and no chlorides.
3. No shrinkage when tested in conformity with ASTM C827/C827M.

B. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to ASTM C1107/C1107M for Grades B, C, D and CRD-C621 nonshrink grout:
  - a. Setting Time:
    - 1) Initial: Approximately two hours.
    - 2) Final: Approximately three hours.
    - 3) Comply with ASTM C191.
  - b. Maximum Expansion: 0.10 to 0.40 percent.
  - c. Minimum Compressive Strength:
    - 1) One-Day: 4,000 psi.
    - 2) Seven-Day: 7,000 psi.
    - 3) 28-Day: 10,000 to 10,800 psi.
    - 4) Comply with CRD-C621.

## 2.4 FORMWORK

- A. As specified in this Section and in Section 033000 "Cast-in-Place Concrete."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017300 "Execution" for requirements for installation examination.
- B. Verify areas to receive grout.

### 3.2 PREPARATION

- A. Section 017300 "Execution" for requirements for installation preparation.
- B. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by the Engineer.
- C. Remove defective concrete, ice, laitance, dirt, oil, grease, form release agents, paints and other foreign material from concrete surfaces, which may affect the bond or performance of the grout by brushing, hammering, chipping, sand blasting or other similar dry mechanical means until sound and clean concrete surface is achieved. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
  - 1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- D. Roughen concrete lightly, but not to interfere with placement of grout.
- E. Remove foreign materials from metal surfaces in contact with grout.
- F. Align, level, and maintain final positioning of components to be grouted.
- G. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of nonshrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface or other method acceptable to the Engineer. Upon completion of the 24-hour period, remove visible water from the surface prior to grouting.
- H. Nonshrink epoxy grouts do not require saturation of concrete substrate. Do not wet concrete surfaces to receive nonshrink epoxy grout. Completely dry surfaces in contact with epoxy grout before grouting.
- I. Support equipment during alignment and installation of grout by shims, wedges, blocks or other approved means. Prevent bond of shims, wedges and blocking devices by bond breaking coatings and remove after grouting unless otherwise approved by the Engineer. Grout voids created by the removal of shims, wedges, and blocks.

### 3.3 INSTALLATION - GENERAL

- A. Formwork:

1. Construct leakproof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.
3. As specified in Section 033000 "Cast-in-Place Concrete."

B. Mixing - Portland Cement Grout:

1. Use proportions of two parts sand and one part cement, measured by volume.
2. Prepare grout with water to obtain consistency to permit placing and packing.
3. Mix water and grout in two steps:
  - a. Premix using approximately 2/3 of water.
  - b. After partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing two to three minutes.
4. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
5. Do not add additional water after grout has been mixed.
6. Minimum Compressive Strength (ASTM C579):
  - a. In 48 hours: 2,400 psi.
  - b. In 28 days 7,000 psi.

C. Placing of Grout:

1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by using wet burlap bags, soaker hoses or ponding.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three days.

E. Reflect all existing underlying expansion joints, partial contraction joints, and construction joints through the grout.

### 3.4 INSTALLATION - NONSHRINK EPOXY GROUTS

- A. Mix in accordance with manufacturer's recommendations. Mix full batches only, to maintain proper proportions of resin, hardener and aggregate. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Do not entrain air bubbles by mixing too quickly.



- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 degrees For above 90 degrees F.
- C. Place grout rapidly and continuously to avoid cold joints. Place grout in lifts in accordance with manufacturer's recommendations.
- D. Provide forms as specified in Paragraph 3.3A. Place grout into the designated areas and prevent entrapment of air. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. Minimize 'shoulder' length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- F. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- G. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1,000 psi or as recommended by the manufacturer, whichever is longer.

### 3.5 SCHEDULE

- A. Use particular types of grout as follows:
  - 1. General Purpose Nonshrink Cementitious Grout (CRD-C621 Grade D): Use at locations where nonshrink grout is indicated, except for base plates greater in area than 3-feet wide by 3-feet long.
  - 2. Flowable (precision) Nonshrink Cementitious Grout (CRD-C621 Grade B or C): Use under base plates greater in area than 3-feet wide by 3-feet long. Use at locations indicated to receive flowable (precision) nonshrink grout. Flowable (precision), nonshrink, cementitious grout may be substituted for general purpose nonshrink cementitious grout.
  - 3. Nonshrink Epoxy Grout: Use at all locations specifically indicated to receive nonshrink epoxy grout.
  - 4. Cement Grout: Use where indicated.

END OF SECTION 036000



## SECTION 040120.63 - BRICK MASONRY REPAIR

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Repairing brick masonry.

#### 1.3 DEFINITIONS

- A. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- B. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of brick to freezing and thawing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and locations of replacement bricks on the structure, showing relation of existing and new or relocated units.
  - 2. Show provisions for expansion joints or other sealant joints.
  - 3. Show provisions for flashing, lighting fixtures, conduits, and weep holes as required.
  - 4. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.
- C. Samples for Verification: For the following:
  - 1. Each type of brick unit to be used for replacing existing units. Include sets of Samples to show the full range of shape, color, and texture to be expected. For each brick type, provide straps or panels containing at least four bricks. Include multiple straps for brick with a wide range.
  - 2. Each type of patching compound in the form of briquettes, at least 3 inches long by 1-1/2 inches wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.

3. Accessories: Each type of accessory and miscellaneous support.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver bricks to Project site strapped together in suitable packs or pallets or in heavy-duty cartons and protected against impact and chipping.
- B. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- E. Store sand where grading and other required characteristics can be maintained, and contamination avoided.
- F. Handle bricks to prevent overstressing, chipping, defacement, and other damage.

#### 1.6 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits: Repair brick masonry only when air temperature is between 40 and 90 deg F and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Cold-Weather Requirements: Comply with the following procedures for masonry repair unless otherwise indicated:
  1. When air temperature is below 40 deg F, heat mortar ingredients, masonry repair materials, and existing masonry walls to produce temperatures between 40 and 120 deg F.
  2. When mean daily air temperature is below 40 deg F, provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for seven days after repair.
- D. Hot-Weather Requirements: Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F and above unless otherwise indicated.
- E. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Source Limitations: Obtain each type of material for repairing brick masonry (brick, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

### 2.2 MASONRY MATERIALS

- A. Face Brick: As required to complete brick masonry repair work.
  - 1. Brick Matching Existing: Units with colors, color variation within units, surface texture, size, and shape that match existing brickwork.

### 2.3 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white or gray, or both where required for color matching of mortar.
  - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Masonry Cement: Not permitted.
- D. Mortar Cement: Not permitted.
- E. Mortar Sand: ASTM C144.
  - 1. Exposed Mortar: Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
  - 2. Colored Mortar: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
- F. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.
- G. Water: Potable.

### 2.4 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Engineer's approval.
  - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.
- C. Do not use admixtures in mortar unless otherwise indicated.
- D. Mixes: Mix mortar materials in the following proportions:
  - 1. Rebuilding (Setting) Mortar by Volume: ASTM C270, Proportion Specification, 1 part portland cement, 1 part lime, and 6 parts sand.
  - 2. Rebuilding (Setting) Mortar by Type: ASTM C270, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime.

### PART 3 - EXECUTION

#### 3.1 PROTECTION

- A. Prevent mortar from staining face of surrounding masonry and other surfaces.
  - 1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
  - 2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
  - 3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

#### 3.2 MASONRY REPAIR, GENERAL

- A. Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from 20 feet away by Engineer.

#### 3.3 PAINTING STEEL UNCOVERED DURING THE WORK

- A. Notify Engineer if steel is exposed during masonry removal. Where Engineer determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:
  - 1. Surface Preparation: Remove paint, rust, and other contaminants according to SSPC-SP 2, "Hand Tool Cleaning" SSPC-SP 3, "Power Tool Cleaning" or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning", as applicable to comply with paint manufacturer's recommended preparation.
  - 2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).

- B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch, notify Engineer before proceeding.

#### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Engineer's Project Representatives: Engineer will assign Project representatives to help carry out Engineer's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Engineer's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

#### 3.5 MASONRY WASTE DISPOSAL

- A. Masonry Waste: Remove masonry waste and legally dispose of off Owner's property.

END OF SECTION 040120.63





## SECTION 042200 - CONCRETE UNIT MASONRY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Concrete masonry units.
  - 2. Mortar and grout.
  - 3. Steel reinforcing bars.
  - 4. Masonry-joint reinforcement.
  - 5. Embedded flashing.
  - 6. Miscellaneous masonry accessories.

#### 1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of the following:
  - 1. Masonry units.
    - a. Include material test reports substantiating compliance with requirements.
    - b. For masonry units, include data and calculations establishing average net-area compressive strength of units.
  - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
  - 3. Mortar admixtures.
  - 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  - 5. Grout mixes. Include description of type and proportions of ingredients.
  - 6. Reinforcing bars.

7. Joint reinforcement.
  8. Anchors, ties, and metal accessories.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
  2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- C. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

#### 1.8 FIELD CONDITIONS

- A. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  2. Protect sills, ledges, and projections from mortar droppings.
  3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.
  1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.

### 2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
  - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

## 2.4 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide square-edged units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C90.
  - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
  - 2. Density Classification: Normal weight.
  - 3. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.

## 2.5 FACE BRICK

- A. Match existing.

## 2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
  - 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: Not permitted.
- E. Mortar Cement: Not permitted.
- F. Aggregate for Mortar: ASTM C144.
  - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
  - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C404.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

I. Water: Potable.

## 2.7 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M, Grade 60.

B. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.

1. Walls: Hot-dip galvanized carbon steel.
2. Wire Size for Side Rods: 0.148-inch diameter.
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Spacing of Cross Rods: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

## 2.8 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
2. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, G60 zinc coating.
3. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
4. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie made from 0.25-inch-diameter, hot-dip galvanized steel wire.

## 2.9 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
  - 1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.

## 2.10 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

## 2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use portland cement-lime only.
  - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Grout for Unit Masonry: Comply with ASTM C476.
  - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
  - 2. Proportion grout in accordance with ASTM C476, Table 1.
  - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

### 3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

### 3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Match to existing.

### 3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
  - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
  - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
  - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
  - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.
- E. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

### 3.6 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
  - 1. Space reinforcement not more than 16 inches o.c.
  - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.



### 3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
  - 1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  - 3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### 3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
  - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
  - 2. Install preformed control-joint gaskets designed to fit standard sash block.
  - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
  - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

### 3.9 FLASHING

- A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

### 3.10 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
  - 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  - 2. Limit height of vertical grout pours to not more than 60 inches.

### 3.11 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.
  - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
  - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
  - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
- G. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

### 3.12 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

END OF SECTION 042200



## SECTION 050519 - POST-INSTALLED ANCHORS AND REINFORCING BARS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Post-installed adhesive and expansion anchors for concrete substrates.
- 2. Post-installed reinforcing bar dowels using adhesive anchoring system.
- 3. Proof testing of post-installed adhesive anchoring system for anchors and reinforcing bar dowels.

- B. Related Requirements:

- 1. Section 033000 "Cast-In-Place Concrete" and related Sections for concrete, reinforcement, and accessories.
- 2. Various Sections in Division 05 related to metals.
- 3. Various Sections in Divisions 26 related to facility utilities.
- 4. Various Sections in Divisions 40, 41, 43, and 46 related to process mechanical equipment.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site .

- 1. Review methods and procedures related to post-installed anchors including, but not limited to, the following:
  - a. Verify specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
  - b. Materials, material application, sequencing, tolerances, and required clearances.
  - c. Temperature, humidity & moisture limitations for adhesive anchoring system.
  - d. Manufacturer's instructions for installation of expansion anchors and adhesive anchoring system.
  - e. Quality-control program.
  - f. Coordination with building occupants.
- 2. Attendees:
  - a. Resident Engineer.
  - b. Contractor.

#### 1.4 ACTION SUBMITTALS

- A. Submit in accordance with Section 013300 “Submittal Procedures.”
- B. Post-Installed Expansion Anchors:
  - 1. Design Data: Submit manufacturer’s specifications and data including recommended design values and physical characteristics for expansion anchors.
  - 2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed expansion anchors installed into cracked concrete .
  - 3. Installation Procedures: Submit procedures stating product proposed for use, and complete installation method.
- C. Post-Installed Adhesive Anchoring System:
  - 1. Design Data: Submit manufacturer’s specifications and data including recommended design values and physical characteristics, including temperature, humidity, and moisture limitations for adhesive anchoring system.
  - 2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed adhesive anchoring system installed into cracked concrete.
  - 3. Installation Procedures: Submit procedures stating method of drilling, product proposed for use, and complete installation method.
- D. Post-Installed Adhesive Anchoring System Testing:
  - 1. Equipment Data: Manufacturer's information for equipment to be used to conduct proof tests on adhesive anchoring system. Submit diagrams showing geometry of proof test equipment relative to the anchors and reinforcing bar dowels to be tested and calibration data for system of jacks and gauges, including:
    - a. Calibration: Conducted by a certified testing laboratory, of the complete proof test assembly, together as a unit. Conduct assembly calibration within one month prior to conducting first test and present in the form of a plot of gauge pressure versus actual jack force.
    - b. Project Specific Diagram: Laboratory's proposed test equipment setups for monitoring elongation of anchors and reinforcing bar dowels during proof tests. Meet the requirements of ASTM E488 . Have proposed test equipment completely independent of the jack and include a micrometer dial gauge capable of measuring anchor extension to nearest 0.001 inch having 3 inches of travel and be mounted on an adjustable tripod or other device with flexible extension arms or a goose neck to permit rapid alignment of the dial gauge axis with the axis of the anchor.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Installation procedure: Submit installation procedure for post-installed adhesive anchoring system; including method of drilling.

B. Certificates:

1. Installer Qualifications for Adhesive Anchoring System: Submit installer and testing agency qualifications as stated in following Paragraph of this Article.
2. Submit current International Code Council (ICC) Evaluation Service Reports (ESR) for expansion anchors and adhesive anchoring system, for installation into cracked concrete, as applicable, indicating conformance with current ICC Evaluation Service (ICC-ES) Acceptance Criteria.
3. Seismic Qualification Certificates for Post-installed Concrete Anchors. Indicate whether certification is based on actual test of assembled components or on calculations.

C. Qualification Data:

1. Installer: Indicate manufacturer's training date and a list of personnel trained on installation of adhesive anchoring system.

D. Evaluation Reports: From ICC-ES for expansion anchors and adhesive anchoring system, for installation of post-installed anchors into cracked concrete, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

## 1.6 QUALITY ASSURANCE

A. General: Coordinate with the work of other Sections, field verifying dimensions and work of other trades adjoining items of work before installing items specified in this Section.

B. Representatives of post-installed anchor system manufacturer:

1. Proof Testing: Be on site periodically for assistance during installation and testing/inspection of their respective products system, subsystem, or component. Observe, guide and provide instruction on Contractor's assembly, erection, installation or application procedures during the drilling, placement, injection and testing. Inspect, check, and make adjustments as required for the product to function as warranted by the manufacturer and as necessary to furnish the Manufacturer's Certification of Proper Installation.

C. Adhesive Anchoring System:

1. Installer Training: Conduct thorough training by the manufacturer or the manufacturer's representative. Training shall consist of the complete installation process for post-installed anchors and reinforcing bar dowels, including but not limited to:
  - a. Tool selection.
  - b. Hole drilling procedure.
  - c. Hole preparation and cleaning techniques.
  - d. Adhesive injection technique and dispenser training and maintenance.
  - e. Anchor preparation and installation.
  - f. Reinforcing bar dowels preparation and installation.
  - g. Proof loading and torqueing.
  - h. Temperature, humidity, and moisture limitations.
  - i. Working time limitations.

j. Setting time.

2. Include training for anchors and reinforcing bar dowels installed horizontally or upwardly inclined to support sustained tension loads. Install horizontally or upwardly inclined anchors and reinforcing bar dowels by personnel certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent.
3. Manufacturer's Certificate of Proper Installation: Submit upon completion of work, for the post-installed anchors and reinforcing bar dowels, including non-production and production anchors and reinforcing bar dowels.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Handle materials with cranes or derricks. Do not dump material off transportation vehicles or handle in ways that will cause damage.
- C. Store materials elevated above grade and block up so they will not become bent or otherwise damaged.
- D. Repair items that have become damage or corroded to satisfaction of the Engineer prior to incorporating them into the work.

PART 2 - PRODUCTS

2.1 EXPANSION ANCHORS

- A. Fastening to Concrete Substrate: Zinc plated carbon steel wedge type anchors, complete with zinc plated nuts and washers, unless otherwise noted.
- B. Submerged or Weather Exposed Substrates: ASTM A276 Type 316 stainless-steel wedge type anchors, complete with Type 316 stainless-steel nuts and washers, unless otherwise noted.
- C. Meet ICC ES AC01 or ICC ES AC193.
- D. Length: When length or anchor embedment is not indicated, provide length sufficient to place the wedge and expansion cone portion of the anchor at least 1 inch behind concrete reinforcing steel.
- E. Basis-of-Design:
  1. Anchorage designs indicated are based on Hilti, Kwik-Bolt TZ, unless otherwise noted.
  2. Acceptable Anchors: Hilti Kwik-Bolt TZ; Simpson Strong-Tie Strong Bolt 2 Wedge Anchor; DeWalt Power-Stud+ SD1 DeWalt Power-Stud+ SD6 for stainless steel; or equal.



## 2.2 ADHESIVE ANCHORING SYSTEM

- A. Fastening to Concrete Substrate: Manufactured system consisting of post installed threaded rods, nuts, washers, other anchoring hardware, and chemical dispenser for installation in hammer drilled holes.
1. Anchors: Meet ICC ES AC308.
  2. Injection Adhesive: Two-component epoxy system consisting of a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep both components separate.
  3. Adhesive Cartridge: Side-by-side design to accept a static mixing nozzle which thoroughly blends both components and allows injection directly into a drilled hole.
  4. Anchor: Type 316 stainless steel as indicated.
    - a. Basis-of-Design:
      - 1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
      - 2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.
  5. Reinforcing Bar Dowels: Reinforcing bar, per Section 033000.
    - a. Basis-of-Design:
      - 1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
      - 2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.

## 2.3 PERFORMANCE REQUIREMENTS

- A. Performance: design anchors and reinforcing bar dowel anchorage for all anticipated loads and load combinations per ASCE/SEI 7 including omega-naught ( $\Omega_o$ ) factors as applicable.
- B. Seismic Performance: post-installed concrete anchors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
  2. Component Importance Factor is ( $I_p$ ):
    - a. Component Importance Factor ( $I_p$ ) = 1.5 for components meeting the conditions indicated in ASCE/SEI 7.
    - b. Component Importance Factor ( $I_p$ ) = 1.0 for all other components.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General:

1. Install anchoring system in strict compliance with manufacturer's published installation instructions and approved Shop Drawings. Comply with recommended surface preparation, temperature, and moisture of substrate and ambient conditions.
2. Coordinate installation with Special Inspector.
3. Use drill bit of correct diameter and drill to required depth using rotary impact type hammer drills with carbide-tipped bits.
4. Drill holes perpendicular to concrete surface, unless otherwise indicated.
5. Use oil free compressed air to blast out loose particles and dust from drilled holes.

#### B. Expansion anchors:

1. Check expansion anchors for tightness a minimum of 24 hours after initial installation.

#### C. Adhesive anchoring system:

1. Perform installation only by personnel trained in anchor installation and having certification required in PART 1 - GENERAL.
2. Inject adhesive and install anchors and reinforcing bar dowels that are clean and free of dirt, oil, grease, ice or other deleterious material which would reduce bond.

END OF SECTION 050519

## SECTION 051200 - STRUCTURAL STEEL FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Structural steel.

- B. Related Requirements:

- 1. Section 036000 "Grouting" for grouting.
  - 2. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.

#### 1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

#### 1.4 COORDINATION

- A. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: Show fabrication of structural-steel components.

- 1. Erection drawings, detailed shop drawings, anchor bolt placement drawings, schedules, and data for all structural steel
  - 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 3. Include embedment Drawings.
  - 4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For erector fabricator testing agency.
- B. Welding certificates.
- C. Mill test reports for structural steel, including chemical and physical properties.
- D. Product Test Reports: For the following:
  1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
- E. Survey of existing conditions.

#### 1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU.
- B. Erector Qualifications: A qualified erector who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Comply with applicable provisions of the following specifications and documents:
  1. AISC 303.
  2. AISC 360.
  3. RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
  2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F1852 fasteners and for retesting fasteners after lubrication.
- C. Store welding electrodes as recommended by the manufacturer and to avoid damage by moisture or contaminants.

## PART 2 - PRODUCTS

### 2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles-Shapes: ASTM A36/A36M.
- C. Plate and Bar: ASTM A36/A36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B, structural tubing.
- E. Welding Electrodes: AWS A5.1, E70XX.

### 2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
- B. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers.
  1. Finish: Mechanically deposited zinc coating.
- C. Headed Anchor Rods: ASTM F1554, Grade 55, weldable, straight.
  1. Nuts: ASTM A563 heavy-hex carbon steel.
  2. Plate Washers: ASTM A36/A 36M carbon steel.
  3. Washers: ASTM F436, Type 1, hardened carbon steel.
  4. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

### 2.3 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
  1. Camber structural-steel members where indicated.
  2. Fabricate beams with rolling camber up.
  3. Identify high-strength structural steel according to ASTM A6/A6M and maintain markings until structural steel has been erected.

4. Mark and match-mark materials for field assembly.
  5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."
- F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.4 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

## 2.5 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  2. Surfaces to be field welded.
  3. Surfaces of high-strength bolted, slip-critical connections.
  4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  5. Galvanized surfaces.
  6. Surfaces enclosed in interior construction.

- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
  - 1. SSPC-SP 2, "Hand Tool Cleaning."
  - 2. SSPC-SP 3, "Power Tool Cleaning."
  - 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
  - 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
  - 5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
  - 6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
  - 8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
  - 9. SSPC-SP 8, "Pickling."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
  - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

## 2.6 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.
  - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
  - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

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

### 3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of baseplate.
  - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  - 4. Grout in accordance with Section 036000.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
  - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.



### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work. Do no welding when surfaces are wet, exposed to rain, snow or wind, or when welders are exposed to inclement conditions that will hamper good workmanship.
  - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
- C. Assign each bolting crew and each welder an identification mark. Make this mark at each completed connection with a paint stick.
  - 1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  - 2. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

### 3.5 FIELD QUALITY CONTROL

- A. Allow the Engineer or testing agency engaged by Owner free access to the work. Notify the Engineer in writing 4 working days in advance of high strength bolting and field welding operations, including pre-installation verification of high strength bolt assemblies. The Engineer will inspect the following or Owner will engage a testing agency.
  - 1. Structural-steel materials and inspect steel frame joint details.
  - 2. Weld materials and inspect welds.
  - 3. Connection materials and inspect high-strength bolted connections.
- B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Welded connections will be visually inspected according to AWS D1.1/D1.1M.
  - 1. In addition to visual inspection, welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at Owner's testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E165.
    - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    - c. Ultrasonic Inspection: ASTM E164.
    - d. Radiographic Inspection: ASTM E94.

- D. In addition to visual inspection, field-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
  - 1. Bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  - 2. Testing according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

### 3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup for field painting are specified in Section 099100 "Painting" and Section 099656 "Epoxy Painting."

END OF SECTION 051200

## SECTION 054000 - COLD-FORMED METAL FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings:

- 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
  - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

#### 1.4 DELEGATED DESIGN SUBMITTAL

- A. Delegated-Design Submittal: For cold-formed steel framing.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.

- B. Welding certificates.

- C. Product Certificates: For each type of code-compliance certification for studs and tracks.

- D. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
  - 1. Include loads as applicable for the project including but not limited to the following:
    - a. Dead Loads: Weights of materials and construction and the weight of wall mounted equipment.
    - b. Live Loads: 10 psf lateral load acting in either direction.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
  - 1. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
    - a. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft..
  - 2. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

3. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
  - a. Upward and downward movement of 1 inch.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
  1. Wall Studs: AISI S211.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

## 2.2 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
  1. Grade: ST33H.
  2. Coating: G60, A60, AZ50, or GF30.
- B. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
  1. Grade: 33.
  2. Coating: G60.

## 2.3 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: 0.0428 inch.
  2. Flange Width: 1-5/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: Matching steel studs.
  2. Flange Width: 1-1/4 inches.
- C. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
  - a. Minimum Base-Metal Thickness: 0.0428 inch.
  - b. Flange Width: 1 inch plus the design gap for one-story structures.
2. Inner Track: Of web depth indicated, and as follows:
  - a. Minimum Base-Metal Thickness: 0.0428 inch.
  - b. Flange Width: Sum of outer deflection track flange width plus 1 inch.

## 2.4 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
  1. Supplementary framing.
  2. Bracing, bridging, and solid blocking.
  3. Web stiffeners.
  4. Anchor clips.
  5. End clips.
  6. Foundation clips.
  7. Gusset plates.
  8. Stud kickers and knee braces.
  9. Joist hangers and end closures.
  10. Hole-reinforcing plates.
  11. Backer plates.

## 2.5 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
- B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with design capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
  1. Uses: Securing cold-formed steel framing to structure.
  2. Type: Torque-controlled expansion anchor or adhesive anchor.
  3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
  4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

- C. Power-Actuated Anchors: Fastener systems with design capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
  - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- E. Welding Electrodes: Comply with AWS standards.

## 2.6 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M.
- B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

## 2.7 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
  - 1. Fabricate framing assemblies using jigs or templates.
  - 2. Cut framing members by sawing or shearing; do not torch cut.
  - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
  - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:
  - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
  - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- B. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

#### 3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
  - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.



1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
  - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
  - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

### 3.4 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
  1. Stud Spacing: 16 inches.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  1. Install double deep-leg deflection tracks and anchor outer track to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
  1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
  2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

### 3.5 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

### 3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

## SECTION 055000 - METAL FABRICATIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Steel support brackets.
4. Steel base plates for other than structural steel or equipment.
5. Miscellaneous items fabricated from steel, aluminum, ,or stainless steel.
6. Castings.
7. Metal floor plate .
8. Loose bearing and leveling plates for applications where they are not specified in other Sections.

- B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

- C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 036000 "Grouting" for non-shrink grout.
3. Section 050519 "Post-Installed Anchors and Reinforcing Bars" for anchors in various substrates.
4. Section 051200 "Structural Steel Framing" for structural steel components.
5. Section 055313 "Bar Gratings" for various types of bar grating assemblies.
6. Various Sections in Divisions 40 - 46 for process mechanical work scopes.

### 1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Paint products.
- B. Samples:
  - 1. Submit samples as requested by the Engineer during construction.
- C. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
  - 1. Miscellaneous steel items.
  - 2. Miscellaneous aluminum items.
  - 3. Miscellaneous stainless-steel items.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by aluminum, steel and stainless-steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
  - 1. Certify that welders have been qualified under AWS, within previous 12 months, to perform welds required under this Section.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless steel."
- C. Evaluation Reports: Post-installed concrete anchors, from ICC-ES for expansion anchors and adhesive anchor system, for installation into cracked concrete, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

## 1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

## PART 2 - PRODUCTS

### 2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Wide Flange Shapes: ASTM A992.
- C. Steel Angles, Channels, Plates, and Bars: ASTM A36/A36M.
- D. Stainless-steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304, Type 316, Type 316L for welded components.
- E. Stainless-steel Bars and Shapes: ASTM A276, Type 304, Type 316, Type 316L for welded components.
- F. Steel Hollow Structural Sections: ASTM A500/A500M, Grade B cold-formed steel tubing.
- G. Steel Pipe: ASTM A53/A53M, Type S Grade B Standard Weight (Schedule 40) unless otherwise indicated.
- H. Aluminum Extruded Pipe: ASTM B429, Alloy 6063 T6 and Alloy 6061 T6 as indicated.
- I. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.
- J. Aluminum Extrusions: ASTM B221, Alloy 6061 T6.
- K. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- L. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.
- M. Stainless steel Bolts: ASTM F593, Type 316.

- N. Stainless-steel Nuts: ASTM F594, Type 316.
- O. Carbon Steel Bolts and Studs: ASTM A307, Grade A (hot-dip galvanized nuts and washers where noted)
- P. High Strength Steel Bolts, Nuts and washers: ASTM F3125, Grade A325 (mechanically galvanized per ASTM B695, Class 50, where noted).
  - 1. Elevated Temperature Exposure: Type I.
  - 2. General Application: Type I or Type II.
- Q. Galvanizing: ASTM A123, Zn w/0.05 percent minimum Ni.
- R. Galvanizing, hardware: ASTM A153, Zn w/0.05 percent minimum Ni.
- S. Galvanizing, anchor bolts: ASTM F2329, Zn w/0.05 percent minimum Ni.
- T. Welding electrodes, steel: AWS A5.1 E70xx.

## 2.2 FASTENERS

- A. Unless otherwise noted, provide steel machine bolts for the connection of carbon steel ; galvanized steel or stainless-steel machine bolts for the connection of galvanized steel ; and stainless-steel machine bolts for the connection of aluminum.
- B. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  - 1. Provide stainless-steel fasteners for fastening aluminum.
  - 2. Provide stainless-steel fasteners for fastening stainless steel.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- D. Mechanically Galvanized Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM F 3125, Grade A325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.
- E. Stainless steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 2.
- F. Machine bolts and nuts conforming to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.
- G. Toggle Bolts: shall be Hilti, Toggler Bolt or equal.
- H. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in

concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

## 2.3 MISCELLANEOUS ALUMINUM

- A. Miscellaneous Aluminum: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal threads on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Weld on unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous Aluminum Items: Beams, angles, closure angles, grates, floor plates, stop plates, stair nosings, and other miscellaneous aluminum indicated and not otherwise specified.
- D. Angle Frames for Beams, Grates, and Similar Items: Complete with welded strap anchors attached.
- E. Stair Treads for Aluminum Stairs: As specified for grating and having cast abrasive non-slip nosing as approved.
- F. Aluminum Finishes:
  - 1. Anodized Finish: Give an anodic oxide treatment in accordance with AA M31C22A41.

## 2.4 MISCELLANEOUS STEEL

- A. Miscellaneous Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal thread on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous Steel Items: Beams, angles, lintels, metal stairs detailed on the Drawings, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold-down straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel indicated and not otherwise specified.

- D. Select whether the material is to be galvanized, prime coated, or galvanized and given a prime coat.
- E. Steel pipe pieces for sleeves, lifting attachments and other functions: Schedule 40 pipe unless otherwise indicated. Wall and floor sleeves, of steel pipe: Provide welded circumferential steel waterstops at mid-length.
- F. Steel Finish Work: Thoroughly cleaned, by effective means, of loose mill scale, rust and foreign matter. Provide one shop coat of primer compatible with finish coat after fabrication but before shipment. Omit paint within 3 inches of proposed field welds. Apply paint to dry surfaces and be thoroughly and evenly spread and well worked into joints and other open spaces.
- G. Galvanizing, where required: Use hot-dip zinc process after fabrication, coating not less than 2 oz/sq.ft. of surface.

## 2.5 MISCELLANEOUS STAINLESS-STEEL

- A. Miscellaneous Stainless-Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints, jointed where least conspicuous. Conceal threads on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Beams, angles, bar racks, and other miscellaneous stainless steel.

## 2.6 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- B. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780 and compatible with paints specified to be used over it.



- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

## 2.7 CASTINGS:

- A. General: Good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes, and other defects. Thoroughly clean castings to remove foreign matter, and deleterious films. Castings will be subjected to a hammer inspection in the field by the Engineer. Damaged castings may be rejected and replaced at no cost to the Owner.
- B. Matching Surfaces: Machine to a true plane surface allowing contact surfaces to seat without rocking. Provide allowances in patterns so specified thickness is not reduced to obtain finished surfaces. Castings will not be acceptable if actual weight is less than 95 percent of theoretical weight computed from dimensions. Provide facilities for weighing castings in the presence of the Engineer.

## 2.8 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/4 by 1 inch, with a minimum 6 inch embedment and 1-1/2- inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

## 2.9 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.
  - 3. Unless otherwise indicated, provide 1/2-inch baseplates with four 5/8-inch anchor bolts and 1/4-inch top plates.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

## 2.10 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.

## 2.11 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

## 2.12 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

## 2.13 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products. Limit maximum nickel (Ni) content of galvanizing zinc to 0.05 percent.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with universal shop primer unless zinc-rich primer is indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
  - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 3. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

## 2.14 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 03 and Division 04 respectively. Install items to be attached to concrete or masonry after such work is completed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.
- B. Touch up abrasions in the shop primer immediately after erection. Paint areas left unprimed for welding after welding.
- C. Clean and repair, after installation, zinc coating which has been burned by welding, abraded, or otherwise damaged. Thoroughly clean damaged area and remove all traces of welding flux and

loose or cracked zinc coating prior to painting. Paint the cleaned area per the requirements of ASTM A780.

- D. Install specialty products in accordance with the manufacturer's recommendations.
- E. Weld headed anchor studs in accordance with manufacturer's recommendations.
- F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- G. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- H. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- I. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- J. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- K. Corrosion Protection: Coat concealed surfaces of aluminum and steel that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
  - 1. Aluminum Contacting a Dissimilar Metal: Apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
  - 2. Aluminum Contacting Masonry or Concrete: Apply a heavy coat of approved alkali resistant paint to the masonry or concrete.
  - 3. Aluminum Contacting Wood: Apply two coats of aluminum metal and masonry paint to the wood.
  - 4. Steel Contacting Exposed Concrete or Masonry: Apply heavy bitumastic troweling mastic.
  - 5. Between aluminum stair treads, and steel supports, insert 1/4 inchthick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

### 3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
  - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- C. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
  - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

### 3.3 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### 3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000



## SECTION 055200 - METAL RAILINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Aluminum pipe guardrails, railings, balusters, and fittings.

- B. Related Requirements:

- 1. Section 033000 "Cast-In-Place Concrete": Execution requirements for placement of anchors, as specified in this Section, in concrete.
  - 2. Section 099100 "Painting": Paint finish.
  - 3. Section 055000 "Metal Fabrications": Attachment plates, angles and channels.
  - 4. Section 050519 "Post Installed Anchors": Execution requirements for placement of anchors specified in this Section.

#### 1.3 ACTION SUBMITTALS

- A. Section 013300 "Submittal Procedures": Requirements for submittals.

- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

#### 1.4 DELEGATED DESIGN SUBMITTAL

- A. Submit calculations demonstrating that the railing system provided will resist the loads specified in the 2015 Virginia Uniform Statewide Building Code. Stamp and seal the calculations by a professional engineer registered in the Commonwealth of Virginia.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- B. Test Reports: Certified copy of mill test reports on each aluminum proposed for use showing physical properties and chemical analysis.

- C. Certificates: Certify that welders have been qualified under AWS within previous 12 months to perform required welds.
- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- E. Qualifications Statements:
  - 1. Submit qualifications for fabricator and erector.
  - 2. Submit manufacturer's approval of fabricator and erector.

## 1.6 QUALITY ASSURANCE

- A. Perform Work for structural aluminum according to AA ADM 1.
- B. Finish welded joints according to NOMMA Guideline 1, Finish #1.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

## 1.7 QUALIFICATIONS

- A. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' experience.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## 1.9 EXISTING CONDITIONS

- A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Provide 2-rail welded pipe railing systems as indicated, fabricated with 1-1/2 inch nominal diameter pipe. Provide Schedule 80 pipe posts, minimum and rails and handrail of Schedule 40 pipe, minimum. Provide continuous posts and top rails. Spacing of posts not to exceed 4 feet 6 inches on center and shall be uniformly spaced except as otherwise indicated. Install railing posts in vertical position.



1. **Welding:** Provide circumferential welds ground smooth and even to produce a railing that is neat in appearance and structurally sound. Weld in conformity with AWS standards for materials being joined. Cope and fasten rail to post connections with continuous welds. Provide handrail system free of burrs, sharp edges or protrusions on welds. Clean and hand buff welds after fabrication so welds and surrounding area blend with the adjacent finish.
    - a. For welding aluminum, use a weld filler alloy that is compatible with alloys to be joined, that will not discolor the pieces to be joined, and that will not be discolored by anodizing.
  2. **Mechanical Fasteners:** Locate unobtrusively in countersunk holes with the top, flush with rail surface.
  3. **Bending:** Form bends in railings as indicated. No distortion of circular railing shape will be allowed. Make bends and terminal sections without use of fittings. Provide corner bends mitered and welded.
- B. Assemble railing in sections as long as practical, but not greater than 24 feet in length. Provide field splice when an assembled section is to be attached to another section. Provide field splices in railing panels that cross over structure expansion joints.
1. **Field Splices:** Use internal splice sleeves located within 8 inches of railing posts. Weld sleeves to rails on one side and fasten with set screws to rails on other side. Detail field splice to take differential expansion between railing system and the supporting structure.
  2. When field splice occurs in a railing panel crossing a structure expansion joint, weld sleeves to rails on one side and be free to slide in the rails on other side. Detail field splice to take same movement as structure expansion joint.
- C. Provide bases or supports for railing posts and handrail as indicated.
1. Where non-removable railing is set in concrete, place posts in 3 inches diameter formed concrete openings and firmly caulk with cement grout. Place posts with centerline 4 inches from edge of concrete; set posts in centerline of concrete curbs.
  2. Railing posts which may collect condensation shall have a 3/16 inch drain hole drilled immediately above concrete encased area, the base flange, or supporting socket on side away from walking area. Fill bottom of rail post between drain hole and bottom of the post with an inert material, such as a compressed closed cell neoprene rod.
  3. Where guardrail and handrail are to be fastened to walls, provide screwed wall flanges fastened to walls with three 3/8 inch stainless-steel expansion anchors. The horizontal projection of handrail support off the wall shall provide 2-1/4 inch minimum clearance around the handrail.
- D. For railing openings, fabricate safety gates of matching pipe and rail material and configuration. Provide self-closing gates with approved stop, latch, and stainless-steel closure spring and hinges.
- E. For railing openings, fabricate barrier chains of stainless-steel having 1/4 inch links, with eleven links per foot. Fasten chains to handrail posts at elevation of each rail. Connect one end of each chain to one post with a 1/4 inch diameter stainless-steel eye bolt and other end connected to other post by means of a heavy chromium plated bronze swivel eye slide harness snap and a similar eye bolt.

1. Acceptable Manufacturers: Eastern Chain Works, Inc., NY; Lawrence Metal Products, Inc.; or equal.
- F. Provide toe boards on railings adjacent to a drop elevation of 4 feet or more. Toeboards are not required on inclined portion of stairway railings or where concrete or steel curbs exist at 4 inches or more in height. Provide toeboards fabricated of 4 inch high channels of same material as railing, having a minimum thickness of 1/8 inch and flanges of not less than 3/4 inch or more than 1-1/2 inch in width. Position toeboards with a maximum clearance of 1/4 inch from floor and fasten to railing posts with 1/4 inch stainless-steel U-bolts, with J-bolts at corner posts, and with clip angles and two 1/4 inch stainless-steel expansion bolts at walls.
- G. Protect railings by paper, an approved coating, or both against scratching, splashes of mortar, paint, or other defacements during transportation, erection, and until adjacent work is complete. Remove protective materials and make surfaces clean and free from stains, marks, or defects.

## 2.2 MATERIALS

- A. Aluminum Railing System: provide a welded seamless, extruded aluminum pipe system.
1. Rails: ASTM B429 Alloy 6063-T6.
  2. Posts: ASTM B429 Alloy 6061-T6.
  3. Splice and reinforcing sleeves, brackets, end caps, toeboards, and similar components: ASTM B221 or ASTM B209, Alloy 6063-T6 or 6061-T6.
  4. Cast Fittings: ASTM B26/B26M, Alloy No. 214.
  5. Railing System Fastening Hardware: ASTM A276, Type 316 stainless-steel.
  6. Finishes: Clear anodized finish after welding, AAMA 611, Class I, AA M12C22A41.

## 2.3 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.4 FABRICATION

- A. Fit and shop-assemble components in largest practical sizes for delivery to Site, but not to exceed 24 feet in length.
- B. Fabricate components with joints tightly fitted and secured. Furnish spigots and sleeves to accommodate site assembly and installation.

- C. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required. Maintain cylindrical cross section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, and consistent with design of component, except where otherwise noted.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where otherwise noted.
- F. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- G. Accurately form components to each other, and to building structure.
- H. Accommodate expansion and contraction of members and building movement without damage to connections or members.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive Work.

#### 3.2 PREPARATION

- A. Clean and strip aluminum where site welding is required.

#### 3.3 INSTALLATION

- A. Install items, except those to be embedded in concrete under Division 03 or installed in masonry under Division 04. Install items to be attached to concrete or masonry after such work is completed in accordance with indicated details. Do not fasten to wood plugs in masonry.
- B. Install components plumb, level, and square, accurately fitted, and free from distortion or defects.
- C. Anchor railings to structure with anchors.
- D. Field-weld anchors as indicated on Shop Drawings. Clean and repair zinc coating which has been burned by welding, abraded, or otherwise damaged. Grind welds smooth. Thoroughly clean damaged area by wire brushing with traces of welding flux and loose or cracked zinc coating removed prior to painting. Touch up damaged galvanizing and coat ends of galvanized railing in the field using the brush-on method to a dry film thickness of not less than 6 mils in accordance with ASTM A780.
- E. Conceal bolts and screws whenever possible.

- F. Assemble with spigots and sleeves to accommodate tight joints and secure installation.
- G. Protect steel surfaces that come into contact with exposed concrete or masonry with a protective coating of an approved heavy bituminous troweling mastic applied in accordance with manufacturer's instructions prior to installation.
- H. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
- I. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to masonry or concrete.
- J. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.
- K. Between aluminum gratings, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4 inch thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

#### 3.4 CLEANING AND PROTECTION

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055200

## SECTION 055313 - BAR GRATINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes metal bar gratings.
- B. Related Requirements:
  - 1. Section 055000 "Metal Fabrications" for grating supports.
  - 2. Section 055200 "Metal Railings" for structural metal pipe and tube handrails and railings.

#### 1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of grating with installation of related items. Deliver such items to Project site in time for installation.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Clips and anchorage devices for gratings.
  - 2. Paint products.
  - 3. Manufacturers' published load tables.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work. Identify size, material, and location of supporting members and forward requirements to Section 055000 "Metal Fabrications".

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Mill Certificates: Signed by manufacturers of aluminum, and steel certifying that products furnished comply with requirements.
- B. Welding certificates qualified in the previous 12 months.

- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

## 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

## 1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Provide grating conforming to ANSI/NAAMM MBG 531, Type P-19-4, size of grating as shown on Drawings. Do not exceed fabricator's maximum recommended grating span.
- B. Limit grating deflection to 1/4 inch maximum for a uniform live load of 100 psf on maximum span.

### 2.2 METAL BAR GRATINGS

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."
- B. Pressure-Locked Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars.
  1. Grating Mark P-19-4 (2 x 3/16) STEEL: 2-by-3/16-inch bearing bars at 1-3/16 inches o.c., and crossbars at 4 inches o.c.
  2. Traffic Surface: Plain.
  3. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.
- C. Pressure-Locked, Rectangular-Bar Aluminum Grating: Fabricate by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
  1. Bearing Bar Spacing: 1-3/16 inches o.c.
  2. Bearing Bar Depth: As indicated on the drawings.
  3. Bearing Bar Thickness: 3/16 inch.
  4. Crossbar Spacing: 4 inches o.c.
  5. Traffic Surface: Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive.

6. Aluminum Finish: Mill finish.

## 2.3 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- C. Wire Rod for Bar Grating Crossbars: ASTM A510.
- D. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30.
- E. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33, with G90 coating.
- F. Welding Electrodes: Steel filler, AWS A5.1 E70xx.

## 2.4 ALUMINUM

- A. General: Provide alloy and temper recommended by aluminum producer for type of use indicated, with not less than the strength and durability properties of alloy, and temper designated below for each aluminum form required.
- B. Extruded Bars and Shapes: ASTM B221, alloys as follows:
  1. Grating Bearing Bars: 6061-T6 or 6063-T6.
  2. Grating Crossbars: 6061-T1.
- C. Aluminum Sheet: ASTM B209, Alloy 5052-H32.
- D. Welding electrode, aluminum: 5356 filler alloy.

## 2.5 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners. Select fasteners for type, grade, and class required.
  1. Provide stainless-steel fasteners for fastening aluminum.
  2. Provide stainless-steel fasteners for fastening steel.
- B. Grating clamps, nuts, bolts, washers and other fastening devices for grating shall be Type 316 stainless steel. Anchor grating to supporting system using saddle clips.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563 and, where indicated, flat washers.
- D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group 2.

## 2.6 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.7 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
- F. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
  - 1. Provide no fewer than four saddle clips for each grating section with each clip designed and fabricated to fit over two bearing bars.
  - 2. Provide no fewer than four weld lugs for each grating section containing rectangular bearing bars 3/16 inch or less in thickness and spaced less than 15/16 inch o.c., with each lug shop welded to two or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
  - 3. Furnish threaded bolts with nuts and washers for securing grating to supports.
  - 4. Furnish self-drilling fasteners with washers for securing grating to supports.
- G. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
- H. Additional Fabrication:
  - 1. Edge-band openings in grating that interrupt one or more bearing bars with bars of same size and material as bearing bars.



2. Do not notch bearing bars at supports to maintain elevation.
3. For openings 2 inches or greater in diameter or dimension, band grating edges with a bar of same depth and thickness as bearing bars. Weld cut bearing bars or cross bars to banding bar.
4. Provide trench grating with symmetrical cross bar arrangement.
5. Fabricate metal frames and supports for grating of same material as grating, unless otherwise indicated.

## 2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I.

## 2.9 STEEL FINISHES

- A. Finish gratings.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordinate locations and elevations of grating supports provided under provisions of Section 055000 "Metal Fabrications." Verify that members are properly installed to support bar gratings specified in this Section.
- B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Install assemblies in accordance with manufacturer's installations instructions. Install products plumb, level, and square, unless otherwise required by the design.
- B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction and grating supports.
- C. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- D. Provide additional supports at penetrations through grating in order to meet design criteria.

- E. Fit exposed connections accurately together to form hairline joints.
  - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with AWS recommendations and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
- G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

### 3.3 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners as specified.
- C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

### 3.4 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055313

## SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Wood blocking and nailers.

#### 1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
  - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
  - 1. Preservative-treated wood.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that

periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## PART 2 - PRODUCTS

### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  - 1. Factory mark each piece of lumber with grade stamp of grading agency.
  - 2. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

### 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2.
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

### 2.3 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - 1. Blocking.
  - 2. Nailers.

- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

## 2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  - 1. For pressure-preservative-treated wood, use stainless-steel fasteners.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
  - 1. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking and similar supports to comply with requirements for attaching other construction.
- C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- D. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- E. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
  2. Use copper naphthenate for items not continuously protected from liquid water.
- F. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
  2. ICC-ES evaluation report for fastener.
- H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

### 3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

### 3.3 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

## SECTION 070150.19 - PREPARATION FOR REROOFING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Partial tear-off to permit modifications to existing roofing.

#### 1.3 DEFINITIONS

- A. EPS: Molded (expanded) polystyrene.
- B. Partial Roof Tear-off: Removal of selected components and accessories from existing roofing system.
- C. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.
- D. Roof Re-Cover Preparation: Existing roofing system is to remain and be prepared for new roof installed over it.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
  - 1. Include certificate that Installer is approved by warrantor of existing roofing system.
  - 2. Include certificate that Installer is licensed to perform asbestos abatement.
- B. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations.
  - 1. Submit before Work begins.

- C. Landfill Records: Indicate receipt and acceptance of demolished roofing materials and hazardous wastes, such as asbestos-containing materials, by a landfill facility licensed to accept them.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Certified statement from TREMCO stating that existing roof warranty has not been affected by Work performed under this Section.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Approved by warrantor of existing roofing system to work on existing roofing.
- B. Regulatory Requirements:
  - 1. Comply with governing EPA notification regulations before beginning roofing removal.
  - 2. Comply with hauling and disposal regulations of authorities having jurisdiction.

#### 1.8 FIELD CONDITIONS

- A. Existing Roofing System: As indicated in existing roofing warranty.
- B. Owner will occupy portions of building immediately below reroofing area.
  - 1. Conduct reroofing so Owner's operations are not disrupted.
  - 2. Provide Owner with not less than 72 hours' written notice of activities that may affect Owner's operations.
  - 3. Coordinate work activities daily with Owner so Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.
- C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
- D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
- E. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
  - 1. Remove only as much roofing in one day as can be made watertight in the same day.
- F. Hazardous Materials: It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work.
  - 1. Existing roof will be left no less watertight than before removal.



2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner.
  - a. Hazardous materials will be removed by Owner under a separate contract.

## 1.9 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty issued by TREMCO.
  1. Notify warrantor before proceeding with the Work.
  2. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect.
    - a. Submit documentation at Project closeout.

## PART 2 - PRODUCTS

### 2.1 TEMPORARY PROTECTION MATERIALS

- A. EPS Insulation: ASTM C578.
- B. Plywood: DOC PS 1, Grade CD, Exposure 1.
- C. OSB: DOC PS 2, Exposure 1.

### 2.2 TEMPORARY ROOFING MATERIALS

- A. Design and selection of materials for temporary roofing are Contractor's responsibilities.
- B. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft..
- C. Base Sheet: ASTM D4601/D4601M, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet.
- D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt-impregnated, glass-fiber felt.
- E. Asphalt Primer: ASTM D41/D41M.
- F. Roofing Asphalt: ASTM D312/D312M, Type III or IV.
- G. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approvals' RoofNav.

## 2.3 INFILL AND REPLACEMENT MATERIALS

- A. Use infill materials matching existing roofing system materials unless otherwise indicated.
- B. Wood blocking, curbs, and nailers are specified in Section 061053 "Miscellaneous Rough Carpentry."
- C. Fasteners: Factory-coated steel fasteners with metal or plastic plates listed in FM Approvals' RoofNav, and acceptable to new roofing system manufacturer.

## 2.4 AUXILIARY REROOFING MATERIALS

- A. General: Use auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new roofing system.

# PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Protection of In-Place Conditions:
  - 1. Protect existing roofing system that is not to be reroofed.
  - 2. Loosely lay 1-inch-minimum thick, EPS insulation over existing roofing in areas not to be reroofed.
    - a. Loosely lay 15/32-inch plywood or OSB panels over EPS. Extend EPS past edges of plywood or OSB panels a minimum of 1 inch.
  - 3. Limit traffic and material storage to areas of existing roofing that have been protected.
  - 4. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
  - 5. Comply with requirements of existing roof system manufacturer's warranty requirements.
- B. Seal or isolate windows that may be exposed to airborne substances created in removal of existing materials.
- C. Shut off rooftop utilities and service piping before beginning the Work.
- D. Test existing roof drains to verify that they are not blocked or restricted.
  - 1. Immediately notify Engineer of any blockages or restrictions.
- E. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work.
  - 1. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

- F. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
- G. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday.
  - 1. Prevent debris from entering or blocking roof drains and conductors.
    - a. Use roof-drain plugs specifically designed for this purpose.
    - b. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
  - 2. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding.
    - a. Do not permit water to enter into or under existing roofing system components that are to remain.

### 3.2 ROOF TEAR-OFF

- A. Partial Roof Tear-off: Where indicated on Drawings, remove existing roofing down to deck.
  - 1. Remove fasteners from deck.

### 3.3 DECK PREPARATION

- A. Inspect deck after tear-off of roofing system.
- B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify Engineer.
  - 1. Do not proceed with installation until directed by Engineer.
- C. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Engineer.
  - 1. Do not proceed with installation until directed by Engineer.
- D. Provide additional deck securement as indicated on Drawings.

### 3.4 INFILL MATERIALS INSTALLATION

- A. Immediately after roof tear-off, and inspection and repair, if needed, of deck, fill in tear-off areas to match existing roofing system construction.
  - 1. Installation of wood blocking, curbs, and nailers is specified in Section 061053 "Miscellaneous Rough Carpentry."

### 3.5 DISPOSAL

- A. Collect demolished materials and place in containers.
  - 1. Promptly dispose of demolished materials.
  - 2. Do not allow demolished materials to accumulate on-site.
  - 3. Storage or sale of demolished items or materials on-site is not permitted.
- B. Transport and legally dispose of demolished materials off Owner's property.

END OF SECTION 070150.19

## SECTION 075556.13 - FLUID-APPLIED PROTECTED MEMBRANE ROOFING REPAIRS

### 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.
- B. Existing Roofing: The existing roofing system is Tremco AlphaGuard MT. Complete repairs to the roofing using only this product for the roofing membrane.
- C. Maintenance of Existing Warranty: The roofing system is currently under an original warranty. Complete all work to maintain the existing warranty for the remaining full term.
  - 1. The following information is taken from the current warranty, a copy of which will be provided.
    - a. Manufacturer: TREMCO INC., Roofing and Building Maintenance Division.
    - b. Type: "20-year QA Plus Warranty – Revised."
    - c. Warranty Number: 170748.
    - d. Date of Job Completion: December 30, 2016.
    - e. Installer: W T I – Cleveland; 3735 Green Road – North Bldg, Beachwood, OH 44122.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fluid-applied, roofing membrane.
  - 2. Base flashing sheet materials.
  - 3. Roof insulation.
  - 4. Ballast.

#### 1.3 DEFINITIONS

- A. Roofing Terminology: See ASTM D1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Fluid-applied, roofing membrane.
  - 2. Base flashing sheet materials.
  - 3. Primer.

4. Elastomeric sheet.
5. Metal termination bars.
6. Reinforcing fabric.
7. Protection course.
8. Roof insulation.
9. Insulation accessories.
10. Ballast.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For each of the following products:

1. Flashing material, of color required.
2. Aggregate ballast in gradation and color to match the existing indicated.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of compliance with performance requirements.

C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranties: For manufacturer's revised warranties.

## 1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

- B. Handle and store roofing materials, and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

#### 1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Apply roofing within the range of ambient and substrate temperatures recommended by roofing system manufacturer. Do not apply roofing to a damp or wet substrate or when temperature is below 0 deg F.
  - 1. Do not apply roofing in snow, rain, fog, or mist.

#### 1.10 WARRANTY

- A. Warranty: Provide manufacturer warranty agreeing to extend the current warranty, including the new work, for the remaining warranty period.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain roofing materials from single source from single manufacturer.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.

#### 2.3 ROOFING MEMBRANE

- A. Fluid-Applied, Rubberized-Asphalt Roofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt. Match existing roofing.
  - 1. Products: Provide the following: Substitutions are not permitted.
    - a. Tremco Incorporated: AlphaGuard MT.

#### 2.4 BASE FLASHING SHEET MATERIALS

- A. Flashing Sheet: Match existing.

## 2.5 AUXILIARY ROOFING MEMBRANE MATERIALS

- A. Auxiliary materials recommended by roofing manufacturer for intended use and compatible with roofing membrane, matching the existing.

## 2.6 ROOF INSULATION AND ACCESSORIES

- A. Match existing.

## 2.7 BALLAST

- A. Ballast: Reserve and reuse the existing. Provide ballast to match existing when additional ballast is required.
- B. Roof Pavers: Match existing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
  - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof drain bodies are securely clamped in place.
  - 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations.
  - 3. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.
  - 4. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions.
- B. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.
- C. Mask off adjoining surfaces not receiving roofing to prevent spillage from affecting other construction.



- D. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

### 3.3 JOINTS, CRACKS, AND TERMINATIONS

- A. Prepare and treat substrates to receive roofing, including joints and cracks, roof drains, and penetrations, according roofing system manufacturer's written instructions.

### 3.4 INSTALLATION OF BASE FLASHING

- A. Install base flashing at terminations of roofing according to manufacturer's written instructions.
- B. Prime substrate with primer if required by manufacturer.
- C. Bond elastomeric flashing sheet in contact adhesive against wall substrate to within 3 inches of deck. Adhere remaining vertical leg and horizontal leg of flashing sheet in a layer of hot fluid-applied, rubberized asphalt.
- D. Bond modified bituminous flashing sheet to substrate to match existing.
- E. Extend flashing sheet up walls or parapets a minimum of 8 inches above insulation and 6 inches onto roof deck.
- F. Install termination bars and mechanically fasten to top of flashing sheet at terminations and perimeter of roofing.

### 3.5 INSTALLATION OF ROOFING MEMBRANE

- A. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow to dry.
- B. Apply according to manufacturer's written instructions.
- C. Start application with manufacturer's authorized representative present.

### 3.6 INSTALLATION OF INSULATION

- A. Match installation method used for existing insulation.

### 3.7 INSTALLATION OF BALLAST

- A. To roofed area, apply aggregate ballast uniformly to match existing.

### 3.8 INSTALLATION OF ROOF PAVERS

- A. Install roof pavers over roofed area according to insulation manufacturer's written instructions.

### 3.9 FIELD QUALITY CONTROL

- A. Engage a full-time site representative qualified by roofing manufacturer to inspect substrate conditions; surface preparation; and application of membrane, base flashings, protection, insulation, and ballast; furnish daily reports.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
  - 1. Notify Engineer and Owner 48 hours in advance of date and time of inspection.

### 3.10 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Engineer and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

### 3.11 EXISTING ROOFING WARRANTY

- A. Included after this section.

END OF SECTION 075556.13

WARRANTY NUMBER: 170748

OWNER: County of Arlington

ADDRESS: 3402 South Glebe Road, Arlington, VA 22202

BUILDING DESCRIPTION: Arlington Waste Water Control: *Preliminary Treatment Building #3139*

ADDRESS: 3402 South Glebe Road, Arlington, VA 22202

ROOF AREA: 5,800 sq. ft.

DATE OF JOB COMPLETION: December 30, 2016

INSTALLATION PRICE: \$188,155.76

ROOFING SYSTEM: Replacement: AlphaGuard MT

INSTALLATION CONTRACTOR: W T I - Cleveland

ADDRESS: 3735 Green Rd-North Bldg, Beachwood, OH 44122

Tremco Incorporated (hereinafter "Tremco") hereby warrants to the above-named Owner that, subject to the terms, conditions, and limitations stated herein, it will repair leaks in the Tremco Roofing System identified above (hereinafter "TRS") for a period of twenty (20) years from the date of job completion. The term "TRS" shall be defined as the weatherproofing assembly and its components, which includes the following: membrane, insulation, flashings, all sheet metal-related details, and termination details as specified by Tremco.

Tremco will also provide the following maintenance-related services (Services, as defined below) to the Owner during the Warranty term to assist the Owner in properly maintaining the TRS and in maximizing its useful life and performance. All Services will be performed in a good and workmanlike manner in accordance with good roofing practices. Any Services that do not meet these standards will be corrected at no charge to the Owner.

### A. SERVICES: INSPECTIONS, HOUSEKEEPING AND PREVENTIVE MAINTENANCE

In year two (2), year five (5), year ten (10), and year fifteen (15) of this warranty, Tremco shall provide the following roof inspections, preventive maintenance, and limited housekeeping Services on the TRS. (If the Owner has purchased a TremCare Service Agreement in addition to this Warranty, the Services, including inspections and related-reporting, will be carried out in accordance with the TremCare Service Agreement.)

#### 1. Roof Inspections

##### A. Roof Inspections consist of the following:

- Visual inspection of the roof membrane and roof surface conditions.
- Visual inspection of the flashing systems including the metal edge system, base flashings on equipment and adjoining walls, counter flashing and termination details, soil stacks and vents, roofing details, and rooftop projections such as pitch pans, HVAC equipment, skylights and access hatches.

##### B. Roof Inspections do not include:

- Inspection for internal or latent water damage or mold growth.
  - Detection or identification of mold or other latent conditions.
- Any core cuts or other testing or analysis beyond visual inspection.



Quality Assurance Program

## 2. Preventive Maintenance

### A. Preventive Maintenance consists of the following minor repairs and maintenance to:

- Flashing components and details – Such as patching of minor flashing details and penetrations; reinforcement of open flashing laps; and sealing of open metal edge laps, coping joints, expansion joint laps, fasteners, pitch pans, storm collars and similar areas.
- Roof membrane – Such as repair of incidental splits, tears, open laps, or breaks in the membrane.
- Drains, Gutters & Scuppers – Such as tightening of accessible drain bolts and clamping rings; advising Owner of missing drain strainers; and drain details, unsecured gutters and open gutter joints.

### B. Preventive Maintenance does not include:

- Repairs or maintenance of any building component other than the TRS, except as expressly stated above.
- Remediation, detection or abatement of mold.
- Recoating or other significant repair to, or replacement of, the roof membrane.

## 3. General Rooftop Housekeeping

### A. General Rooftop Housekeeping consists of the following:

- Removal of debris (such as leaves, branches, paper and similar items) from the roof membrane and drainage areas.
- Disposal of debris will be at the Owner's approved on-site location and is the sole responsibility of the Owner.

### B. General rooftop housekeeping does not include removal of items such as obsolete HVAC components, any construction materials left by other trades, or other equipment or tools left on the roof by the Owner or third parties.

The Services do not include extensive roof repairs, recoating, restoration or roof replacement unless those steps are determined by Tremco to be necessary in order to maintain compliance with the terms of the TRS Warranty. Removal of chemical or other manufacturing or industrial pollution and discharge is the sole responsibility of the Owner and is expressly excluded from coverage under the Warranty and is not within the scope of the Services. The Owner will be advised of any extensive repairs required and whether such repairs are covered under this Warranty prior to those repairs being undertaken.

## **B. ROOF INSPECTION REPORTS**

Tremco will provide roof inspection reports to the Owner based upon the inspections as defined in Section A above. The reports shall become part of the OLI<sup>®</sup> database maintained on the TRS. Roof inspection reports will not address the presence of mold or water damage to any building components other than the TRS.

## **C. OWNER'S RESPONSIBILITIES**

Tremco does not assume possession or control of any part of the Owner's facility (including the installed TRS) through this Warranty or otherwise. Once payment for the TRS and its installation is made in full, then such control and ownership are solely with the Owner, which is responsible for compliance with all applicable federal, state or local law, ordinances and regulations. The Owner is responsible for all repair, maintenance, and other work with respect to the TRS and the building, except as expressly stated otherwise in this Warranty. Neither this Warranty nor the Services described above eliminate or replace the building Owner's responsibility for following good roofing practices during the term of the Warranty, including keeping effluent and debris from the roof surface. The Owner shall, at all times, exercise reasonable care in the use and maintenance of the TRS including adherence to the care and maintenance responsibilities contained in the attached Owner's Manual.

Care and maintenance guidelines include, but are not limited to:

- \* Regular ongoing inspection by the Owner between inspections by Tremco - This will allow for implementation of good housekeeping practices and early detection of problems such as any physical damage.

- \* Verification that no alterations or unauthorized repairs have been made to the TRS.

The Owner shall report all leaks which occur in the TRS within the warranty period by immediately (within 24 hours) contacting Tremco at 1-800-422-1195, followed by written notice to Tremco Incorporated at 3735 Green Road, Beachwood, Ohio 44122, as soon as possible (however, in no event more than thirty (30) days) after leakage is or should have been discovered. In no event is Tremco responsible for any repairs to any part of the building other than the TRS. The liability and expense for such repair is with the Owner. If a leak is not within the coverage of this Warranty, Tremco shall advise the Owner, and the Owner shall have repairs performed within thirty (30) days according to Tremco specifications by a Tremco certified or approved applicator. Tremco reserves the right to charge the Owner in connection with responding to and inspecting building leaks that are not covered by the Warranty, including without limitation building leaks through windows, HVAC units, walls or other building components that are not part of the TRS. Such charges will be at Tremco's standard rates then in effect and Owner agrees to pay such charges on a net 30-day basis from the date of invoice. The Owner agrees to provide Tremco with unrestricted ready access to the TRS and all areas of the building on which the TRS is located.

#### **D. EXTENDED OR RENEWED WARRANTY OPTION**

The TRS you have purchased may be eligible for Warranty extension, or renewal after expiration, beyond the Term identified on page one above. Often, extension of the existing Warranty can be a very cost effective option and may be preferable to allowing the Warranty to expire, particularly for Owners with multiple facilities who may not want those buildings coming out of warranty coverage at or about the same time. It is Tremco's practice to contact Owners regarding our Warranty and renewal options at or about sixty (60) days prior to Warranty expiration. We also invite Owners to contact their Tremco Sales Representative at any time to discuss the applicable terms, conditions and eligibility for such an extension or renewal.

#### **E. WARRANTY EXCLUSIONS**

This Warranty does not cover any leaks, damage or failure of the TRS or any part thereof caused in whole or in part by any of the following:

1. Natural or accidental disasters including, but not limited to, damage caused by lightning, hailstorms, floods, winds in excess of 74 mph, tornadoes, earthquakes, fire, vandalism, animals, penetration of the membrane, or chemical attack by outside agents.
2. Use of materials not specified by Tremco, or repairs to the TRS that are not approved in advance in writing by Tremco.
3. Any intentional or negligent act on the part of the Owner or any third party including, but not limited to, abuse, misuse, traffic, or storage of or discharge of materials or effluent on the roof.
4. Failure of building components such as parapet walls, copings, chimneys, skylights, vents or roof deck or other faulty building construction or design.
5. Lack of positive, proper, or adequate roof drainage or ponding conditions.
6. Change in building usage without prior written approval from Tremco.

#### **F. WARRANTY LIMITATIONS**

Tremco shall have no responsibility and/or liability under this Warranty until all bills for installation, supplies, and services sold in connection with the TRS have been paid in full.

The Owner's rights under this Warranty are specific to the Owner and are not assignable or transferable.

Tremco may void its obligations under this Warranty based on the occurrence of the events described in Section E or failure of the Owner to comply with its obligations described in this Warranty, including with respect to payment of all bills related to the TRS or its installation, proper TRS care and maintenance and leak reporting. Tremco makes no warranty as to appearance of the TRS or any aesthetic condition.

**THIS WARRANTY IS IN LIEU OF ANY AND ALL OTHER WARRANTIES, OBLIGATIONS OR AGREEMENTS, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY**

PARTICULAR PURPOSE, ALL OF WHICH ARE EXPRESSLY EXCLUDED. THE REMEDIES AND OBLIGATIONS STATED IN THIS WARRANTY ARE THE SOLE AND EXCLUSIVE REMEDIES OF, AND OBLIGATIONS TO, THE OWNER FOR ANY AND ALL MATTERS ARISING WITH RESPECT TO OR IN ANY WAY CONNECTED WITH THE TRS, ITS COMPONENTS OR ANY GOODS OR SERVICES RELATED THERETO, REGARDLESS OF THE SOURCE OR PROVIDER OF SUCH GOODS OR SERVICES. NO REPRESENTATIVE OF TREMCO, OR ANY EMPLOYEE, AGENT OR AFFILIATED COMPANY (COLLECTIVELY "TREMCO") HAS AUTHORITY TO VARY OR ALTER THESE TERMS, WITHOUT EXPRESS WRITTEN PERMISSION OF A TREMCO OFFICER. IN NO EVENT SHALL TREMCO BE LIABLE FOR ANY DAMAGE TO THE BUILDING ITSELF (OTHER THAN THE TRS), THE CONTENTS OF THE BUILDING, OR ANY OTHER SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES. TREMCO'S TOTAL LIABILITY OVER THE LIFE OF THE WARRANTY, SHALL NOT IN ANY EVENT EXCEED IN DOLLAR VALUE THE INSTALLED CONTRACT PRICE OF THE TRS AS IT APPEARS ABOVE. THIS TOTAL LIABILITY SHALL BE PRO-RATED ON A STRAIGHT LINE BASIS OVER THE LIFE OF THE WARRANTY, AND TREMCO'S LIABILITY SHALL NOT EXCEED SUCH PRO-RATED AMOUNT. TREMCO SHALL NOT BE LIABLE FOR ANY DAMAGES WHICH ARE BASED UPON NEGLIGENCE, BREACH OF WARRANTY, STRICT LIABILITY OR ANY OTHER THEORY OF LIABILITY OTHER THAN THE EXCLUSIVE LIABILITY SET FORTH IN THIS WARRANTY.

The Owner agrees that this Warranty, and the Services and remedies set forth herein, are sole and exclusive, and there are no other warranties between the Owner and Tremco. Any unresolved issues under this Warranty shall be submitted to the exclusive jurisdiction of the state or federal courts of Cuyahoga County, Ohio, and governed by Ohio law without regard to choice of law principles.

It is expressly understood and agreed by the parties of this warranty that the Surety's liability, if any, under its performance bond with respect to warranty liabilities shall be limited to a one-year period, which shall begin when the customer accepts delivery or makes final payment in accordance with the terms of the contract. Tremco Incorporated, its successors, and/or assigns, shall be solely responsible for the balance of the term of its warranty in accordance with the terms found therein.

TREMCO INCORPORATED  
ROOFING & BUILDING MAINTENANCE DIVISION

By: 

Title: Warranty Administrator

Date: August 15, 2017

Revision #1

## SECTION 078413 - PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Penetrations in fire-resistance-rated walls.
  - 2. Penetrations in horizontal assemblies.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

#### 1.5 CLOSEOUT SUBMITTALS

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

## 1.6 QUALITY ASSURANCE

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

## 1.7 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

## 1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.
- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

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



## 2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M Fire Protection Products.
    - b. A/D Fire Protection Systems Inc.
    - c. Grabber Construction Products.
    - d. Hilti, Inc.
    - e. HOLDRITE; Reliance Worldwide Company.
    - f. International Fireproof Technology Inc.
    - g. NUCO Inc.
    - h. Passive Fire Protection Partners.
    - i. RectorSeal Firestop; a CSW Industrials Company.
    - j. Roxtec.
    - k. Specified Technologies, Inc.
    - l. STC Sound Control.
    - m. Tremco, Inc.
    - n. Or equal.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
  2. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
  2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
  3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
  4. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
1. Permanent forming/damming/backing materials.
  2. Substrate primers.
  3. Collars.
  4. Steel sleeves.
  5. Temporary forming materials.
  6. Masking Tape: Type recommended by firestopping manufacturer of width required by project conditions.

### 2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

## 2.4 MIXING

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
  - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
  - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

### 3.3 INSTALLATION

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.4 IDENTIFICATION

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

### 3.5 FIELD QUALITY CONTROL

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

### 3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

### 3.7 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Listed Building Products" under "Firestop Systems."
- C. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."
- D. Penetration Firestopping Schedule, General:
  - 1. F-Rating: 2 hours.
  - 2. T-Rating: 2 hours.
  - 3. W-Rating: No leakage of water at completion of water leakage testing.
  - 4. Type of Fill Materials: As required to achieve rating.
  - 5. Types of Systems: As follows:
    - a. Penetration firestopping systems with no penetrating items.
    - b. Penetration firestopping systems for metallic pipes, conduit, or tubing.
    - c. Penetration firestopping systems for electrical cables.
    - d. Penetration firestopping systems for cable trays with electric cables.
    - e. Penetration firestopping systems for insulated pipes.
    - f. Penetration firestopping systems for miscellaneous electrical penetrants.

- g. Penetration firestopping systems for miscellaneous mechanical penetrants.
- h. Penetration firestopping systems for groupings of penetrants.

END OF SECTION 078413

## SECTION 079200 - JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Urethane joint sealants.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- B. Field-Adhesion-Test Reports: For each sealant application tested.
- C. Sample Warranties: For special warranties.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

#### 1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
  - 1. Locate test joints where indicated on Project or, if not indicated, as directed by Engineer.
  - 2. Conduct field tests for each kind of sealant and joint substrate.

3. Notify Engineer seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
  - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
    - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

## 1.7 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
  1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
  2. When joint substrates are wet.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## 1.8 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:



1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## PART 2 - PRODUCTS

### 2.1 JOINT SEALANTS, GENERAL

- A. **Compatibility:** Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. **Colors of Exposed Joint Sealants:** As selected by Engineer from manufacturer's full range.

### 2.2 URETHANE JOINT SEALANTS

- A. **Urethane, S, P, 25, T, NT:** Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.
- B. **Products:** Subject to compliance with requirements, provide one of the following:
  1. BASF Corporation: MasterSeal SL 1 (Pre-2014: Sonolastic SL1).
  2. Pecora Corporation: NR-201.
  3. Permthane®/Acryl-R®: ITW Polymers Sealants North America; Permthane SM7101.
  4. Polymeric Systems, Inc.: Flexiprene 952.
  5. Or equal.

### 2.3 JOINT-SEALANT BACKING

- A. **Sealant Backing Material, General:** Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
  1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
    - a. Adfast.
    - b. Alcot Plastics Ltd.
    - c. BASF Corporation.
    - d. Construction Foam Products; a division of Nomaco, Inc.
    - e. Or equal.
- B. **Cylindrical Sealant Backings:** ASTM C 1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.4 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    - a. Concrete.
    - b. Masonry.
  - 3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. **Joint Priming:** Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. **Masking Tape:** Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. **General:** Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. **Sealant Installation Standard:** Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. **Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.**
  1. Do not leave gaps between ends of sealant backings.
  2. Do not stretch, twist, puncture, or tear sealant backings.
  3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. **Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.**
- E. **Install sealants using proven techniques that comply with the following and at the same time backings are installed:**
  1. Place sealants so they directly contact and fully wet joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. **Tooling of Nonsag Sealants:** Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  1. Remove excess sealant from surfaces adjacent to joints.
  2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

### 3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
  - a. Perform 10 tests for floor joint at interior building perimeter.
2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
  - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
3. Inspect tested joints and report on the following:
  - a. Whether sealants filled joint cavities and are free of voids.
  - b. Whether sealant dimensions and configurations comply with specified requirements.
  - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

### 3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

### 3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
  - 1. Joint Locations:
    - a. Perimeter floor joint.
    - b. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Urethane, S, P, 25, T, NT.
  - 3. Joint-Sealant Color: Black.

END OF SECTION 079200



## SECTION 080163.23 – REMOVAL AND REINSTALLATION OF METAL-FRAMED SKYLIGHT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes removal and reinstallation of the existing metal-framed skylight to accommodate the removal and replacement of equipment through the opening.
- B. Related Requirements:
  - 1. Division 40 and 46 Sections for work related to equipment to be removed and replaced below skylight.

#### 1.3 DEFINITIONS

- A. Low-Pressure Spray: 100 to 400 psi; 4 to 6 gpm.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Include the Engineer, Owner, Contractor, and entity completing the rigging and handling of removal and reinstallation of the skylight.
  - 2. The purpose of the meeting is to coordinate the Owner and Contractor's requirements associated with the skylight removal and replacement only.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.6 INFORMATION SUBMITTALS

- A. Rigging and Handling Plan: For the record only. The plan is accepted for informational purposes only and will not be subject to approval.
- B. Include the following, for informational purposes only.
  - 1. Storage and handling information.

2. Equipment schedule.
3. Plan indicating laydown areas and staging areas.
4. Aviation requirements.
5. Other information.

#### 1.7 STORAGE AND HANDLING

- A. Temporary Storage: Store skylight in the indicated laydown area, off the ground on wood pallets or similar blocking. Cover the skylight during storage with protective sheeting and other protective materials to prevent damage.
- B. Handling: Handle skylight during removal to prevent damage.

### PART 2 - PRODUCTS

#### 2.1 GASKET MATERIALS

- A. Gaskets: Flat design of foam rubber, sponge neoprene, or cork.

#### 2.2 METAL CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F.
- C. Detergent Solution: Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate, 1/2 cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.

#### 2.3 GLASS CLEANERS

- A. Glass Cleaner: Detergent and ammonia based commercial glass cleaning product.

#### 2.4 FASTENERS

- A. Retain existing fasteners, including nuts bolts, and washers.
- B. Replacement Fasteners: Match to existing for type, material, finish, strength.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION



- A. Examine substrates areas and conditions for compliance with requirements for conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 REMOVAL AND REINSTALLATION OF SKYLIGHT

- A. Prepare laydown areas for temporary installation of skylight during work and removal below opening area, including protective pallets, blocking or similar materials to store skylight off the ground.
- B. Disconnect skylight from curb by removing existing retention bolts, nuts and washers.
- C. Rig the skylight to the lift and pick crane and remove skylight. Store and protect skylight during equipment removal and replacement under opening.
- D. Prior to reinstallation of the existing skylight remove any foreign materials, dirt, rust and other contaminants at the connection joints on the skylight and the curb.
- E. Install a single layer of gasket material at all contact areas at the removal skylight joint and curb prior to reinstallation of the existing skylight. Use existing fasteners, only to the extent that they are not damaged, and replacement fasteners to reinstall skylight.

### 3.3 TEMPORARY PROTECTION OF OPENING

- A. Temporary Weather Protection: Protect the opening during the following periods.
  - 1. During non-work hours.
  - 2. When active operations involving the use of the opening to remove or replace equipment is not required.

### 3.4 METAL CLEANING

- A. Detergent Cleaning:
  - 1. Wet surface with hot water applied by low-pressure spray.
  - 2. Scrub surface with detergent solution and natural-fiber or plastic-bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used, and that surface remains wet.
  - 3. Rinse with hot water applied by low-pressure spray to remove detergent solution and soil.

### 3.5 GLASS CLEANING

- A. Clean glass using commercial glass cleaning materials and squeegees.

END OF SECTION 080163.23

## SECTION 087100 - DOOR HARDWARE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Mechanical door hardware for the following:
    - a. Swinging doors.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  - 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
  - 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
  - 3. Content: Include the following information:
    - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
    - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
    - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
    - d. Fastenings and other installation information.
    - e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
    - f. Mounting locations for door hardware.
    - g. List of related door devices specified in other Sections for each door and frame.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware schedule.

#### 1.5 QUALITY ASSURANCE

- A. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including excessive deflection, cracking, or breakage.
    - b. Faulty operation of doors and door hardware.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-

protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

- B. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- C. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design".
  - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
  - 2. Comply with the following maximum opening-force requirements:
    - a. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

### 2.3 SCHEDULED DOOR HARDWARE

- A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.
  - 1. Door hardware is scheduled in Part 3.

### 2.4 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.
  - 1. Manufacturer: Match to existing.

### 2.5 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock.
  - 1. Existing System:
    - a. Master key or grand master key locks to Owner's existing system.
- B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
  - a. Notation: Information to be furnished by Owner.

## 2.6 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Engineer.
  1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
  1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
  2. Fire-Rated Applications:
    - a. Wood or Machine Screws: For the following:
      - 1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.
      - 2) Strike plates to frames.
      - 3) Closers to doors and frames.

## 2.7 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are

acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Wood Doors: Comply with door and hardware manufacturers' written instructions.

### 3.3 INSTALLATION

- A. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
  - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
  - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- B. Lock Cylinders: Install construction cores to secure building and areas during construction period.
  - 1. Furnish permanent cores to Owner for installation.

### 3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

### 3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.

- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

### 3.6 DOOR HARDWARE SCHEDULE

- A. Lockset: F07 x lever x finish to match existing. Installed in existing door.

END OF SECTION 087100



## SECTION 090110 - CLEANING FINISHES AND SURFACES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes cleaning the following finishes and surfaces:
  - 1. Concrete.
  - 2. Masonry.
  - 3. Painted concrete and masonry.
  - 4. Painted steel.
  - 5. Other surfaces indicated.
  - 6. The work does not include surface preparation for application of finishes include in other sections.
- B. Related Requirements:
  - 1. Section 099100 "Painting" for preparation of surfaces for installation of painting.
  - 2. Section 099656 "Epoxy Coatings" for preparation of surfaces for installation of epoxy coatings.

#### 1.3 DEFINITIONS

- A. Very Low-Pressure Spray: Under 100 psi.
- B. Low-Pressure Spray: 100 to 400 psi.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to cleaning including, but not limited to, the following:
    - a. Construction schedule. Verify availability of materials, Restoration Specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Materials, material application, sequencing, tolerances, and required clearances.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Restoration Specialist, Restoration Workers, Manufacturers, Installer and Applicator.

## 1.7 QUALITY ASSURANCE

- A. Restoration Specialist Qualifications: Engage an experienced cleaning firm, specializing in cleaning the types of surface indicated on the drawings to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance.
- B. Field Supervision: Restoration specialist firms shall maintain experienced full-time supervisors on Project site during times that concrete cleaning work is in progress. Supervisors shall not be changed during Project except for causes beyond the control of restoration specialist firm.
- C. Restoration Worker Qualifications: Persons who are experienced in restoration work of types they will be performing.
- D. Cleaner Manufacturer Qualifications: A firm regularly engaged in producing cleaners that have been used for similar applications with successful results, and with factory-trained representatives who are available for consultation and Project-site inspection and assistance at no additional cost.
- E. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging concrete. Include provisions for supervising performance and preventing damage due to worker fatigue.
- F. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used, protection of surrounding materials, and control of runoff during operations.
  - 1. If materials and methods other than those indicated are proposed for any phase of restoration work, add to the Quality-Control Program a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project and worker's ability to use such materials and methods properly.
- G. Cleaning Appearance Standard: Cleaned and repaired surfaces are to have a uniform appearance as viewed from 20 feet away by Engineer. Perform additional stain removal, general cleaning, and spot cleaning of small areas that are noticeably different, so that surface blends smoothly into surrounding areas.

- H. Mockups: Prepare mockups of cleaning, for each type of surface indicated on the drawings to be cleaned, to demonstrate aesthetic effects and set quality standards for materials and execution and for fabrication and installation.
1. Cleaning: Clean an area of 25 sq. ft for each type of surface condition.
  2. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not use cleaners and methods known to have deleterious effect.
  3. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.
  4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
  5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

## 1.9 FIELD CONDITIONS

- A. Clean concrete surfaces only when air temperature is 40 deg F and above and will remain so for at least 7 days after completion of cleaning.

## 1.10 COORDINATION

- A. Coordinate concrete cleaning with circulation patterns within the building. Circulation patterns cannot be closed off entirely, and in places can be only temporarily redirected around small areas of work. Plan and execute the Work accordingly.
- B. Coordinate concrete cleaning operations with Owner to assure protection of water basins from cleaning materials and contaminants, including overspray.
- C. Materials are restricted to materials that will not contaminate the public wastewater systems operations in proximity to the surfaces being cleaned.

## PART 2 - PRODUCTS

### 2.1 CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F.

C. Provide any of the following cleaning materials, in accordance with the "Part 1 – Quality Assurance, Cleaning Program."

1. Detergent Concrete Cleaners:

a. Products: Provide one of the following:

- 1) Chemical Product Industries, Inc.; iClean SMD.
- 2) Eco-Wares, Inc.; Nu Look Concrete Cleaner.
- 3) PROSOCO; 600 Detergent.
- 4) Or equal.

D. Concrete Rust Stain Removers:

1. Products: Provide one of the following:

- a. Eco-Wares, Inc.; Rust / Stain Remover.
- b. PROSOCO; Concrete Brick Cleaner.
- c. EnviroSafe Manufacturing Corp.; Rust Stain Remover.
- d. Or equal.

E. Painted, Masonry, Steel Surface Cleaners: Detergent based cleaners formulated for cleaning the indicated surfaces.

## 2.2 ACCESSORY MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from damaging effects of concrete cleaners.

1. Products: Provide one of the following:

- a. ABR Products, Inc.; Rubber Mask.
- b. Price Research, Ltd.; Price Mask.
- c. PROSOCO; Sure Klean Strippable Masking.
- d. Or equal.

B. Miscellaneous Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Little possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.

C. Do not use products or tools that could do the following:

1. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
2. Leave a residue on surfaces.

## 2.3 CLEANING SOLUTIONS

- A. Dilute cleaners with water to produce solutions not exceeding concentration recommended in writing by cleaner manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION AND PROTECTION

- A. Protect persons, machinery, electrical equipment, lighting, alarms, all other items and surrounding surfaces of building from harm resulting from concrete cleaning work.
- B. Erect temporary protective covers that must remain in service during course of cleaning work.
- C. Maintain covers in watertight condition for duration of cleaning operations. Remove covers when cleaning operations are completed.
- D. Comply with manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent solutions from coming into contact with people, motor vehicles, and other surfaces that could be harmed by such contact.
- E. Cover adjacent surfaces with materials that are proven to resist cleaners used unless they will not damage adjacent surfaces. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
- F. Keep wall wet below area being cleaned to prevent streaking from runoff.
- G. Neutralize and collect concrete cleaning wastes for disposal off Owner's property. Protect drains with filters to prevent harmful materials from entering drains.

### 3.3 CLEANING CONCRETE, GENERAL

- A. Proceed with cleaning in an orderly manner; work from top to bottom. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.
- B. Use only those cleaning methods indicated for each concrete material and location.

- C. Do not use wire brushes or brushes that are not resistant to cleaner being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist cleaner being used.
- D. Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage concrete.
- E. Equip units with pressure gages.
- F. For spray application, use low-pressure tank or pump suitable for cleaner indicated, equipped with cone-shaped spray tip.
- G. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
- H. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.
- I. For steam application, use steam generator capable of delivering live steam at nozzle.
- J. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging concrete surfaces.
- K. Water Application Methods:
  - 1. Water-Soak Application: Soak concrete surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
  - 2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches from surface of concrete and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- L. Steam Cleaning: Apply steam to concrete surfaces at the very low pressures indicated for each type of concrete material. Hold nozzle at least 6 inches from surface of concrete and apply steam in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- M. Cleaner Application Methods: Apply cleaners to concrete surfaces to comply with manufacturer's written instructions; use brush or spray application. Do not spray apply at pressures exceeding 50 psi. Do not allow cleaners to remain on surface for periods longer than those indicated or recommended by manufacturer.
- N. Rinse off cleaner residue and soil by working upward from bottom to top of each treated area. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that cleaner is completely removed.
- O. Apply neutralizing agent and repeat rinse if necessary, to produce tested pH of between 6.7 and 7.5.

- P. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

### 3.4 CLEANING OTHER THAN CONCRETE, GENERAL

- A. Proceed with cleaning in an orderly manner; work from top to bottom. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.
- B. Use only those cleaning methods indicated for each material and location.
- C. Do not use brushes that are not resistant to cleaner being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist cleaner being used.
- D. Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage concrete. Use pressures that will not result in the removal of painted from painted surfaces.
- E. Equip units with pressure gages.
- F. For spray application, use low-pressure tank or pump suitable for cleaner indicated, equipped with cone-shaped spray tip.
- G. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
- H. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.
- I. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging concrete surfaces.
- J. Cleaner Application Methods: Apply cleaners to surfaces to comply with manufacturer's written instructions; use brush or spray application. Do not spray apply at pressures that will remove paint from surfaces. Do not allow cleaners to remain on surface for periods longer than those indicated or recommended by manufacturer.
- K. Rinse off cleaner residue and soil by working upward from bottom to top of each treated area. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that cleaner is completely removed.
- L. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

### 3.5 PRELIMINARY CLEANING, CONCRETE

- A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
- B. Carefully remove heavy accumulations of material from surface of concrete with a sharp chisel. Do not scratch or chip concrete surface.

### 3.6 PRELIMINARY CLEANING, OTHER THAN CONCRETE

- A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used.

### 3.7 CLEANING CONCRETE

- A. Cold-Water Soak:
  - 1. Apply cold water by intermittent spraying to keep surface moist.
  - 2. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
  - 3. Apply water in cycles with at least 30 minutes between cycles.
  - 4. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
  - 5. Continue spraying for 72 hours.
  - 6. Remove soil and softened surface encrustation from concrete with cold water applied by low-pressure spray.
- B. Cold-Water Wash: Use cold water applied by low-pressure spray.
- C. Hot-Water Wash: Use hot water applied by low-pressure spray.
- D. Steam Cleaning: Apply steam at very low pressures not exceeding 30 psi. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.
- E. Detergent Cleaning:
  - 1. Wet concrete with cold or hot water applied by low-pressure spray.
  - 2. Scrub concrete with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
  - 3. Rinse with cold or hot water applied by low pressure spray to remove detergent solution and soil.
  - 4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

### 3.8 CLEANING OTHER THAN CONCRETE



- A. Clean surface as recommended by the manufacturer in writing.

END OF SECTION 090110



## SECTION 090690 - PAINT COLOR SCHEDULE

### 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. Sections includes paint color schedule to indicate color and textures of paint to be provided.
- B. Related Requirements:
  - 1. Painting is included in Division 09.

#### 1.3 ACTION SUBMITTALS

- A. Samples: Submit the following for each type of coating system and in each color and gloss of finish coat indicated.
  - 1. Color cards for initial color selections.
  - 2. Three sets of 8-in by 8-in samples, on 1/4-in hardboard, of all colors required for all types of paint. Resubmit until approved.

1.4 PAINT COLOR SCHEDULE

ITEM	NUMBER/COLOR
<b>BUILDING EXTERIOR (new)</b>	
Steel bollards	OSHA Safety Yellow
Touch Up	Match adjacent surface
Unscheduled surfaces	Match adjacent surface
<b>BUILDING INTERIOR (existing and new unless otherwise noted)</b>	
Bollards	OSHA Safety Yellow
Gypsum Board	Eggshell White
Touch Up	Match adjacent surface
CMU	Match adjacent surface
Unscheduled surfaces	Match adjacent surface

ITEM	SIGNAGE	COLOR
<b>ELECTRICAL</b>		
Transformers and switchgear	--	Eggshell – Factory Finish
Exposed metal conduit and boxes	--	To match abutting surface
Panelboards	--	To match abutting surface
Mounting channels and misc. support systems	--	White
Motor control centers	--	Eggshell – Factory Finish
Unistrut systems	--	White
Control panels	--	Eggshell – Factory Finish
Light fixture pendants	--	White

<u>ITEM</u>	<u>SIGNAGE</u>	<u>COLOR</u>
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MECHANICAL PIPING SYSTEMS  
(See Mechanical Schematics and Drawings.)

Process Piping:

Drain	Drain	TBS
Overflow	Overflow	TBS
Plant Effluent Water	Plant Effluent Water	TBS
Hot Plant Effluent Water	Hot Plant Effluent Water	TBS
Scum	Scum	TBS
County Owned Water	County Owned Water	TBS

ITEM	SIGNAGE	COLOR
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**PROCESS EQUIPMENT:**

Finish paint all exposed, non-submerged and submerged, ferrous metal surfaces that are not factory finished painted.

Provide equipment Signage for all scheduled equipment listed

Screenings Washer Compactors	Screenings Washer Compactor No. __	TBS
Bar Screens	Bar Screen No. _	TBS
Screw Conveyor	Screw Conveyor No.	TBS
Scum Skimmer Tank	Scum Skimmer Tank	TBS
Scum Skimmer Collector	Scum Skimmer Collector	TBS
Scum Hopper	Scum Hopper	TBS
Scum Hopper Mixer	Scum Hopper Mixer	TBS
Concentrated Scum Pump	Concentrated Scum Pump	TBS
Hot Water Pump	Hot Water Pump	TBS
Hot Water Heater	Hot Water Heater	TBS

Misc. Items:

Post Indicator Valves	Post Indicator Valve	TBS
Fire Hydrants	Fire Hydrant	TBS
Slide Gates	Slide Gate	TBS
Bar Screen Diverter Gate	Bar Screen _ Diverter Gate	
Floor Stands	Floor Stand	TBS
Yard Hydrants	Yard Hydrant	TBS
Wash Hose Stations	Wash Hose Station	TBS
Strainers	Strainer	TBS
Sample Sink	Sample Sink	TBS

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 090690

## SECTION 092900 - GYPSUM BOARD

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Interior gypsum board.

- B. Related Requirements:

- 1. Section 054000 "Cold-Formed Metal Framing" for steel framing that supports gypsum board panels.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

#### 1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, moisture damaged, and mold damaged.

- 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## PART 2 - PRODUCTS

### 2.1 GYPSUM BOARD, GENERAL

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

### 2.2 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Gypsum.
    - b. CertainTeed Corporation.
    - c. Continental Building Products, LLC.
    - d. Georgia-Pacific Gypsum LLC.
    - e. National Gypsum Company.
    - f. PABCO Gypsum.
    - g. USG Corporation.
    - h. Or equal.
  - 2. Thickness: 5/8 inch.
  - 3. Long Edges: Tapered.

### 2.3 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
  - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.

### 2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
  - 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
    - a. Use setting-type compound for installing paper-faced metal trim accessories.



3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

## 2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
  1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
  2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- C. Locate edge and end joints over supports. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- D. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- E. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  - 1. Type X: All locations.
- B. Single-Layer Application:
  - 1. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
  - 2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

### 3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

### 3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
  - 1. Level 4: At panel surfaces that will be exposed to view.

### 3.6 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900



## SECTION 095113 - ACOUSTICAL PANEL CEILINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

#### 1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

### 2.2 ACOUSTICAL PANELS

- A. Provide panels to match existing in classification, color, thickness and manufacturer.

### 2.3 METAL SUSPENSION SYSTEM

- A. Match existing.

### 2.4 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
  - 1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
  - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
  - 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.135-inch-diameter wire.

### 2.5 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile to match existing, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
  - 1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

### 3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.
  - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and

- appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, or power-actuated fasteners that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
  2. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

### 3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.



### 3.5 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113



## SECTION 096513 - RESILIENT BASE AND ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Vinyl base.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

#### 1.5 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 VINYL BASE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Armstrong World Industries, Inc.
  - 2. Burke Mercer Flooring Products; a division of Burke Industries Inc.
  - 3. Flexco.
  - 4. Johnsonite; a Tarkett company.
  - 5. Roppe Corporation, USA.
  - 6. VPI Corporation.
  - 7. Or equal.
- B. Product Standard: ASTM F1861, Type TV (vinyl, thermoplastic).
  - 1. Group: I (solid, homogeneous).
  - 2. Style and Location:
    - a. Style B, Cove: Provide in areas with resilient floor coverings.
- C. Minimum Thickness: 0.125-inch.
- D. Height: Match existing.
- E. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.
- F. Inside Corners: Job formed.
- G. Colors and Patterns: Match existing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
  - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

### 3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. Job-Formed Corners:
  - 1. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
    - a. Miter or cope corners to minimize open joints.

### 3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum horizontal surfaces thoroughly.
  - 3. Damp-mop horizontal surfaces to remove marks and soil.

- C. Protect resilient products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

## SECTION 096519 - RESILIENT TILE FLOORING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Vinyl composition floor tile.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: Full-size units of each color, texture, and pattern of floor tile required.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
  - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

#### 1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following periods:

1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 VINYL COMPOSITION FLOOR TILE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Biltrite.
  2. Armstrong World Industries, Inc.
  3. Congoleum Corporation.
  4. Johnsonite; a Tarkett company.
  5. Or equal.
- B. Tile Standard: ASTM F1066, Class 2, through pattern.
- C. Wearing Surface: Smooth.
- D. Thickness: 0.125 inch.
- E. Size: 12 by 12 inches.
- F. Colors and Patterns: Match existing.

### 2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.



## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
  - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
  - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

### 3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
  - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
  - 1. Lay tiles with grain running in one direction.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

### 3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION 096519

## SECTION 099100 – PAINTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following substrates:
  - 1. Concrete.
  - 2. Concrete masonry units (CMUs).

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.5 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Provide products by one of the following:
  - 1. Tnemec, Inc.(TN);
  - 2. The Sherwin Williams Company (SW)
  - 3. PPG Architectural Finishes, Inc. (PPG)
  - 4. PPG Architectural Finishes, Inc. Ameron (AME)
  - 5. Or equal.

### 2.2 MATERIALS

- A. Material Compatibility:
  - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. Provide products of same manufacturer for each coat in a coating system.
- B. Use paint materials without adulteration and mixed, thinned and applied in strict accordance with manufacturer's directions for the applicable materials and surface.
- C. Colors: As selected by Engineer from manufacturer's full range.

## PART 3 -

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
  - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
    - a. Concrete: 12 percent.
    - b. Masonry (Clay and CMU): 12 percent.
- B. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
  - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  - 4. Paint entire exposed surface of window frames and sashes.
  - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

### 3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Engineer, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.5 PAINTING SCHEDULE

- A. The following types of paints by Tnemec Co. (TN), The Sherwin Williams Company (SW), PPG Protective & Marine Coatings, (PPG), and Ameron International (AME) have been used as a basis for the paint schedule; use one of these paints or equal:
- B. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat as recommended by manufacturer:
  - 1. Previously painted existing concrete/CMU scheduled for painting:
    - a. First Coat:
      - 1) TN: H.B. Tneme-Tufcoat, Series 113.
      - 2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
      - 3) PPG: Aquapon WB Epoxy 98-1 Series.
      - 4) AME: Amercoat 335 WB Epoxy.
    - b. Second Coat:
      - 1) TN: Enviro-Glaze, Series 297.
      - 2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
      - 3) PPG: Aquapon WB Epoxy 98-1 Series.
      - 4) AME: Amercoat 335 WB Epoxy.
  - 2. Gypsum Work:
    - a. First Coat:
      - 1) TN: PVA Sealer No. 51-792.
      - 2) SW: PrepRite 200 Primer, B28 Series.
      - 3) PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
      - 4) AME: Amercoat 148 Acrylic Primer.

b. Second and Third Coats:

- 1) TN: Tneme-Cryl Series 6.
- 2) SW: DTM Primer/Finish, B66 Series.
- 3) PPG: Pitt-tech Plus 90-1110 Series Satin DTM Acrylic.
- 4) AME: Amercoat 220 Waterborne Acrylic.

END OF SECTION 099100





## SECTION 099656 - EPOXY COATINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes epoxy coating systems, consisting of a mortar and finish coating.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's and special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For epoxy coatings to include in maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace epoxy coatings that fail(s) in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 2 years from date of Substantial Completion.

- B. **Manufacturer Warranty:** Manufacturer agrees to repair or replace epoxy coatings that fail(s) in materials within specified warranty period.
  - 1. **Warranty Period:** 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 EPOXY/CEMENT COMBINATION MORTAR

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide “Sikagard® 75 EpoChem,” by Sika Corporation or comparable product by one of the following:
  - 1. Sherwin Williams.
  - 2. TNEMEC.
  - 3. Or equal.
- B. **Description:** Provide a 3-component, solvent-free, moisture-tolerant, epoxy-modified, cementitious, structural resurfacing compound and pore-filling mortar.
- C. **Properties:** As follows:
  - 1. **Compressive Strength:** ASTM C579B; not less than 7000 psi at 28 days.
  - 2. **Flexural Strength:** ASTM C348; not less than 1500 psi at 28 days.
  - 3. **Coefficient of Thermal Expansion:** ASTM C531;  $5.5 \times 10^{-6}$  in./in./F.
  - 4. **Moisture Vapor Transmission:** ASTM E96; 0.06 perms at 7 days.

### 2.2 HIGH-BUILD, PROTECTIVE, SOLVENT-FREE, COLORED EPOXY COATING

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide “Sikagard 62,” by Sika Corporation or comparable product by one of the following:
  - 1. Sherwin Williams.
  - 2. TNEMEC.
  - 3. Or equal.
- B. **Description:** Provide a 2-component, 100% solids, moisture-tolerant epoxy resin. It produces a high-build, protective, dampproofing, and waterproofing vapor-barrier system.
- C. **Properties:** As follows:
  - 1. **Tensile Properties:** ASTM D638.
    - a. **Tensile Strength:** 6,400 psi.
    - b. **Elongation at Break:** 2.7 percent.
  - 2. **Abrasion Resistance:** ASTM D968; Abrasion Coefficient 51 liters/mil. at 14 days.
  - 3. **Adhesion:** ASTM D3359; Adhesion Classification 4A (1 day).

4. Water Absorption: ASTM D570; 0.9 percent (total water absorption (2-hour boil)) at 7 days.
- D. Color: As selected by Engineer from full range of industry colors.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Remove existing coating system to original substrate. Use methods that will not damage the concrete substrates.

#### 3.3 INSTALLATION

- A. Epoxy/Cement Combination Mortar: Repair cracks, and other surface defects using methods recommended by the manufacturer, to provide a surface acceptable to the manufacturer for the installation of the high-build, protective, solvent-free, colored epoxy coating.
  1. Thickness: 80 mils.
  2. Prepare substrates using sandblasting, shotblasting, or other mechanical methods as recommended in writing by the manufactures. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, disintegrated materials.  
Primers: Apply primers recommended by the manufacturer.
  3. Thoroughly mix components. Apply mortar at the application rate recommended by the manufacture and within the environmental limitation required.
- B. High-Build, Protective, Solvent-Free, Colored Epoxy Coating:
  1. Thickness: 10 mils, applied in two coats of 5 mils each.
  2. Prepare and prime surfaces as recommended by the manufacturer.
  3. Mix components are recommended by the manufacturer.
  4. Apply coating using high-quality roller, brush, or spray.

#### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect installation, including connections.

- B. Prepare test and inspection reports.

END OF SECTION 099656

## SECTION 149182 - DEBRIS CHUTES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Debris chutes and accessories.
- 2. Fabric grit chute.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for metal supporting framework at floor penetrations.
- 2. Section 411213 "Screw Bulk Material Conveyors" for the screenings and grit hoppers that will support each debris chute.

#### 1.3 DEFINITIONS

- A. Chase: The shaft that encloses a chute.

- B. Hopper: Supplied under 411213 "Screw Bulk Material Conveyors". The fabricated funnel that collects grit and screenings from the screw conveyors, washing compactors, and grit classifiers, and directs it through the chase connecting the first and second floors. There are two hoppers each will be connected to its own debris chute supplied herein.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chutes.

- B. Shop Drawings:

- 1. Include plans, elevations, sections, and mounting and attachment details.
- 2. Include dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 3. Include each type and location of intake, discharge, and winches.
- 4. Include diagrams for winches, pulleys, and cable routing.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Size and construction of chase enclosing chute
  - 2. Chute-discharge locations coordinated with container, winch and pulley locations.
  - 3. Winch and pulley mounting locations and anchorage details.
- B. Product Certificates: For each type of chute, from manufacturer, including a complete list of materials.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For chutes to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Superchute located in Quebec, Canada or equal

### 2.2 CHUTES

- A. Two Chutes shall be provided as shown on the Drawings; one connected to each hopper on the second floor of the Preliminary Treatment Building directing screenings and grit to the corresponding roll-off container on the first floor.
- B. Each Chute shall be supplied as follows:
  - 1. Chutes shall be comprised of a minimum of 3 sections. Sections shall be designed to nest into each other when retracted and flex freely to allow the Owner to direct screenings and grit along the full length and width of the roll-off containers
  - 2. Chute section shall be attached with 316 stainless-steel cables and u-bolts to the corresponding sections.
  - 3. The bottom chute section shall be supplied with a 316 Stainless Steel lifting collar capable of manipulating the chute discharge location and retracting the chute with the supplied winches.
    - a. Each collar shall be supplied with four (4) attachment points, each at 90 degrees to one another: Two will be for wire rope attachment for manipulating the discharge location along the length of the roll-off container. Two will be for optional rope attachment if the Owner elects to manipulate the chute along the width of the roll-off container.
  - 4. Chute Sections (each section should be interchangeable with identical dimensions)
    - a. Material: UHMW-PE

- b. Maximum section height 36-inches
  - c. Maximum section weight 65 pounds
  - d. Maximum Inlet Diameter 36-inch
  - e. Minimum Outlet Diameter 24-inch
- 5. The top section of each chute shall be hung from the screenings and grit discharge hoppers.
  - 6. The bottom section of each chute shall terminate 6-inches above the top of the roll-off container.
  - 7. Provide two stainless steel 1400 pound hand crank winches with automatic break, 50-75 feet of 3/16 inch stainless steel wire rope per winch, and 316 stainless steel locking spring latch hook on each wire rope.
  - 8. Provide four 316 stainless steel swivel snatch pulleys for ¼-inch cable. Each pulley shall have a 1400 pound working live load with a 5500 pound ultimate load.
    - a. The Contractor shall be responsible for final wire rope routing, pulley and winch mounting locations to avoid conflicts with existing systems. Pulleys not needed for cable routing shall be turned over to the Owner for shelf spares.
    - b. Winch shall be located 4-ft above the finished floor and be located such that the hand crank will have full rotation.
    - c. Wire rope shall be routed to avoid creating an obstruction or hazard to walking areas.
- C. Provide two chute sections as spare parts with associated u-bolts and connecting cables.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install chutes according to manufacturer's written instructions. Assemble components with, nonleaking joints such that all material that enters the hopper is directed to the chute discharge location without clogging or leaking to unintended spaces. Anchor chutes securely to supporting structure to withstand impacts and stresses of compacted screenings and grit from equipment above.
- B. Install chutes plumb, without obstructions that might prevent materials from free falling within chutes when wire rope and winches are not under tension.
- C. Each chute shall be tested with wet screenings and grit. The Contractor shall collect at least two 5-gallons buckets of wet screenings, and two 5-gallon buckets of grit and dump each down the chute being tested. Material shall follow the chute to a location in the roll-off container selected by the Project Officer. All material should flow into the container without hanging up or getting stuck inside the chute.

END OF SECTION 149182





## 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

- B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts" for duct hangers and supports.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 DELEGATED-DESIGN SUBMITTAL:

- A. This requirement applies to exterior piping support for heating water piping.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  1. Trapeze pipe hangers.
  2. Metal framing systems.
  3. Pipe stands.
  4. Equipment supports.

- C. For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail fabrication and assembly of trapeze hangers.
  - 2. Include design calculations for designing trapeze hangers.
- D. Support details shown on the drawings are indicative and do not relieve the Contractor of the design responsibilities indicated above.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

## 1.6 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.
- C. Qualification Data: For professional engineer and testing agency.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design wind restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

### 2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Stainless-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

## 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural stainless-steel shapes with MSS SP-58 stainless steel hanger rods, nuts, saddles, and U-bolts.

## 2.4 METAL FRAMING SYSTEMS

A. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Anvil International.
  - b. Gripple Inc.
  - c. MIRO Industries.
  - d. RectorSeal HVAC; a CSW Industrials Company.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted stainless-steel channel with inturred lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
8. Metallic Coating: No coating.

## 2.5 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. National Pipe Hanger Corporation.
2. Pipe Shields Inc.
3. Piping Technology & Products, Inc.

- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Eaton (B-line).
    - b. Hilti, Inc.
    - c. MKT Fastening, LLC.
  - 2. Indoor Applications: stainless-steel.
  - 3. Outdoor Applications: Stainless steel.

## 2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
  - 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
  - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
  - 3. Hardware: stainless steel.
  - 4. Accessories: Protection pads.
- C. Low-Profile, Single Base, Single-Pipe Stand:
  - 1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
  - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
  - 3. Vertical Members: Two, stainless-steel, continuous-thread 1/2-inch rods.
  - 4. Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.
  - 5. Pipe Supports: Roller or Strut clamps as indicated.
  - 6. Hardware: Stainless steel.

7. Accessories: Protection pads.
8. Height: 12 inches above roof.

- D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## 2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural stainless steel shapes.

## 2.9 MATERIALS

- A. Aluminum: ASTM B221.
- B. Structural Steel: ASTM A36/A36M, stainless steel plates, shapes, and bars.
- C. Stainless Steel: ASTM A240/A240M.
- D. Threaded Rods: Continuously threaded. Stainless steel for indoor and outdoor applications. Mating nuts and washers of similar materials as rods.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  1. Properties: Nonstaining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static load used for strength determination shall be weight of supported components plus 200 lb.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A36/A36M, stainless steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation:
  - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
  - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use stainless steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- E. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- F. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.



- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  3. Stainless steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
  7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
  11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or stainless steel plate.
  15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or stainless steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  2. Stainless-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529



## 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Duct labels.
  - 5. Valve tags.
  - 6. Warning tags.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Brady Corporation.

- b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
- 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
  - 3. Letter Color: White.
  - 4. Background Color: Black.
  - 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  - 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  - 8. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
- 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Red.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater

viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

## 2.4 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: White.

- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: Refer to table below Include secondary lettering two-thirds to three-quarters the size of principal lettering.

OUTSIDE DIAMETER OF DUCT	SIZE OF LETTERS
6-inch and Less	1-1/2-inch
8-inch to 10-inch	2-1/2-inch
Over 10-inch	3-inch

- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

## 2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.



## 2.6 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
  - 1. Size: 3 by 5-1/4 inches minimum.
  - 2. Fasteners: Brass grommet and wire or Reinforced grommet and wire or string.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Color: Safety-yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### 3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
1. Heating Water Piping: White letters on a safety-green background.
  2. Refrigerant Piping: Black letters on a safety-orange background.
  3. Condensate Piping: White letters on a safety-purple background.

### 3.5 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
  2. Yellow: For hot-air supply ducts.
  3. Green: For foul air ducts.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
    - a. Hot Water: 1-1/2 inches, round.
  2. Valve-Tag Colors:

- a. Hot Water: White letters on a safety-green background.

### 3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553



## 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Balancing Air Systems:
  - a. Constant-volume air systems.
- 2. Balancing Hydronic Piping Systems:
  - a. Constant-flow hydronic systems.
  - b. Variable-flow hydronic systems.
  - c. Primary-secondary hydronic systems.
- 3. Testing, Adjusting, and Balancing Equipment:
  - a. Motors.
  - b. Condensing units.
  - c. Heat-transfer coils.
- 4. Testing, adjusting, and balancing existing systems and equipment.
- 5. Duct leakage tests.
- 6. Control system verification.

#### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

- G. TDH: Total dynamic head.

#### 1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
  - 1. Minimum Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Needs for coordination and cooperation of trades and subcontractors.
    - d. Proposed procedures for documentation and communication flow.

#### 1.5 ACTION SUBMITTALS

- A. Certified TAB reports for the Engineer's review.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 90 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 90 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Final Certified TAB reports addressing Engineer's review.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

## 1.7 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC or NEBB.
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC or NEBB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

## 1.8 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment

performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:
    - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
    - b. Duct systems are complete with terminals installed.
    - c. Volume, smoke, and fire dampers are open and functional.
    - d. Clean filters are installed.
    - e. Fans are operating, free of vibration, and rotating in correct direction.
    - f. Variable-frequency controllers' startup is complete, and safeties are verified.
    - g. Automatic temperature-control systems are operational.
    - h. Ceilings are installed.



- i. Windows and doors are installed.
  - j. Suitable access to balancing devices and equipment is provided.
2. Hydronics:
- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
  - b. Piping is complete with terminals installed.
  - c. Water treatment is complete.
  - d. Systems are flushed, filled, and air purged.
  - e. Strainers are pulled and cleaned.
  - f. Control valves are functioning per the sequence of operation.
  - g. Shutoff and balance valves have been verified to be 100 percent open.
  - h. Pumps are started, and proper rotation is verified.
  - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
  - j. Variable-frequency controllers' startup is complete, and safeties are verified.
  - k. Suitable access to balancing devices and equipment is provided.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  1. Unless otherwise noted, after testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  2. Where noted, after testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
  3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.

- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements. Obtain confirmation from Engineer that proposed test locations are acceptable.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
  - 2. Measure fan static pressures as follows:
    - a. Measure static pressure directly at the fan outlet or through the flexible connection.
    - b. Measure static pressure directly at the fan inlet or through the flexible connection.
    - c. Measure static pressure across each component that makes up the air-handling system.
    - d. Report artificial loading of filters at the time static pressures are measured.
  - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
  2. Adjust submain and branch duct volume dampers for specified airflow.
  3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  2. Measure inlets and outlets airflow.
  3. Adjust each inlet and outlet for specified airflow.
  4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
  2. Re-measure and confirm that total airflow is within design.
  3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
  4. Mark all final settings.
  5. Test system in economizer mode. Verify proper operation and adjust if necessary.
  6. Measure and record all operating data.
  7. Record final fan-performance data.

### 3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
1. Check liquid level in expansion tank.
  2. Check highest vent for adequate pressure.
  3. Check flow-control valves for proper position.
  4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
  5. Verify that motor starters are equipped with properly sized thermal protection.
  6. Check that air has been purged from the system.

### 3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
  - 1. Measure total water flow.
    - a. Position valves for full flow through coils.
    - b. Measure flow by main flow meter, if installed.
    - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
  - 2. Measure pump TDH as follows:
    - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - c. Convert pressure to head and correct for differences in gage heights.
    - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
  - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
  - 1. Measure flow in main and branch pipes.
  - 2. Adjust main and branch balance valves for design flow.
  - 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
  - 1. Measure flow at terminals.
  - 2. Adjust each terminal to design flow.
  - 3. Re-measure each terminal after it is adjusted.
  - 4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
  - 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
  - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
  - 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
  - 1. Measure and balance coils by either coil pressure drop or temperature method.

2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

### 3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

- a. Measure total water flow.

- 1) Position valves for full flow through coils.
- 2) Measure flow by main flow meter, if installed.
- 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

- b. Measure pump TDH as follows:

- 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
- 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
- 3) Convert pressure to head and correct for differences in gage heights.
- 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
- 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

- a. Measure flow in main and branch pipes.
  - b. Adjust main and branch balance valves for design flow.
  - c. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    - a. Measure flow at terminals.
    - b. Adjust each terminal to design flow.
    - c. Re-measure each terminal after it is adjusted.
    - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
    - e. Perform temperature tests after flows have been balanced.
  4. For systems with pressure-independent valves at terminals:
    - a. Measure differential pressure and verify that it is within manufacturer's specified range.
    - b. Perform temperature tests after flows have been verified.
  5. For systems without pressure-independent valves or flow-measuring devices at terminals:
    - a. Measure and balance coils by either coil pressure drop or temperature method.
    - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
  6. Prior to verifying final system conditions, determine the system differential-pressure set point.
  7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
  8. Mark final settings and verify that all memory stops have been set.
  9. Verify final system conditions as follows:
    - a. Re-measure and confirm that total water flow is within design.
    - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    - c. Mark final settings.
  10. Verify that memory stops have been set.
- D. For systems with diversity:
1. Determine diversity factor.
  2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
  3. Adjust pumps to deliver total design gpm.
    - a. Measure total water flow.
      - 1) Position valves for full flow through coils.

- 2) Measure flow by main flow meter, if installed.
    - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
  - b. Measure pump TDH as follows:
    - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - 3) Convert pressure to head and correct for differences in gage heights.
    - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
  - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
  - a. Measure flow in main and branch pipes.
  - b. Adjust main and branch balance valves for design flow.
  - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
  - a. Measure flow at terminals.
  - b. Adjust each terminal to design flow.
  - c. Re-measure each terminal after it is adjusted.
  - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
  - e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
  - a. Measure differential pressure and verify that it is within manufacturer's specified range.
  - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
  - a. Measure and balance coils by either coil pressure drop or temperature method.
  - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.

9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
  - a. Re-measure and confirm that total water flow is within design.
  - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
  - c. Mark final settings.
13. Verify that memory stops have been set.

### 3.9 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Phase and hertz.
  5. Nameplate and measured voltage, each phase.
  6. Nameplate and measured amperage, each phase.
  7. Starter size and thermal-protection-element rating.
  8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

### 3.10 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

### 3.11 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
  1. Entering- and leaving-water temperature.
  2. Water flow rate.
  3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
  4. Dry-bulb temperature of entering and leaving air.
  5. Wet-bulb temperature of entering and leaving air for cooling coils.



6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

### 3.12 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

### 3.13 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
  1. Verify temperature control system is operating within the design limitations.
  2. Confirm that the sequences of operation are in compliance with Contract Documents.
  3. Verify that controllers are calibrated and function as intended.
  4. Verify that controller set points are as indicated.
  5. Verify the operation of lockout or interlock systems.
  6. Verify the operation of valve and damper actuators.
  7. Verify that controlled devices are properly installed and connected to correct controller.
  8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
  9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

### 3.14 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
  1. Measure and record the operating speed, airflow, and static pressure of each fan.

2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  3. Check the refrigerant charge.
  4. Check the condition of filters.
  5. Check the condition of coils.
  6. Check the operation of the drain pan and condensate-drain trap.
  7. Check bearings and other lubricated parts for proper lubrication.
  8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
  2. Coils are clean, and fins combed.
  3. Drain pans are clean.
  4. Fans are clean.
  5. Bearings and other parts are properly lubricated.
  6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.
  2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
  3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
  4. Balance each air outlet.

### 3.15 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Make-Up Air Units and Exhaust: Plus or minus 5 percent.
  2. Air Handling Units: Plus or minus 10 percent.
  3. Air Outlets and Inlets: Plus or minus 10 percent.
  4. Heating-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.16 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

### 3.17 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Pump curves.
  - 2. Fan curves.
  - 3. Manufacturers' test data.
  - 4. Field test reports prepared by system and equipment installers.
  - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB specialist.
  - 3. Project name.
  - 4. Project location.
  - 5. Engineer's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Terminal units.
  6. Balancing stations.
  7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.
  2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
  3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.

- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Filter static-pressure differential in inches wg.
- f. Preheat-coil static-pressure differential in inches wg.
- g. Cooling-coil static-pressure differential in inches wg.
- h. Heating-coil static-pressure differential in inches wg.
- i. Outdoor airflow in cfm.
- j. Return airflow in cfm.
- k. Outdoor-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

- a. System identification.
  - b. Location.
  - c. Coil identification.
  - d. Capacity in Btu/h.
  - e. Number of stages.
  - f. Connected volts, phase, and hertz.
  - g. Rated amperage.
  - h. Airflow rate in cfm.
  - i. Face area in sq. ft..
  - j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
- a. Heat output in Btu/h.
  - b. Airflow rate in cfm.
  - c. Air velocity in fpm.
  - d. Entering-air temperature in deg F.
  - e. Leaving-air temperature in deg F.
  - f. Voltage at each connection.
  - g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
  - a. System identification.
  - b. Location.
  - c. Make and type.
  - d. Model number and size.
  - e. Manufacturer's serial number.
  - f. Arrangement and class.
  - g. Sheave make, size in inches, and bore.
  - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
  - a. Motor make, and frame type and size.
  - b. Horsepower and rpm.
  - c. Volts, phase, and hertz.
  - d. Full-load amperage and service factor.
  - e. Sheave make, size in inches, and bore.
  - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
  - a. Total airflow rate in cfm.
  - b. Total system static pressure in inches wg.
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg.
  - e. Suction static pressure in inches wg.

- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
  1. Report Data:
    - a. System and air-handling-unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F.
    - d. Duct static pressure in inches wg.
    - e. Duct size in inches.
    - f. Duct area in sq. ft..
    - g. Indicated airflow rate in cfm.
    - h. Indicated velocity in fpm.
    - i. Actual airflow rate in cfm.
    - j. Actual average velocity in fpm.
    - k. Barometric pressure in psig.
  
- J. Air-Terminal-Device Reports:
  1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.
    - f. Number from system diagram.
    - g. Type and model number.
    - h. Size.
    - i. Effective area in sq. ft..
  
  2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm.
    - b. Air velocity in fpm.
    - c. Preliminary airflow rate as needed in cfm.
    - d. Preliminary velocity as needed in fpm.
    - e. Final airflow rate in cfm.
    - f. Final velocity in fpm.
    - g. Space temperature in deg F.
  
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
  1. Unit Data:
    - a. System and air-handling-unit identification.
    - b. Location and zone.
    - c. Room or riser served.
    - d. Coil make and size.
    - e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
  - a. Airflow rate in cfm.
  - b. Entering-water temperature in deg F.
  - c. Leaving-water temperature in deg F.
  - d. Water pressure drop in feet of head or psig.
  - e. Entering-air temperature in deg F.
  - f. Leaving-air temperature in deg F.
  
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
  1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.
    - f. Water flow rate in gpm.
    - g. Water pressure differential in feet of head or psig.
    - h. Required net positive suction head in feet of head or psig.
    - i. Pump rpm.
    - j. Impeller diameter in inches.
    - k. Motor make and frame size.
    - l. Motor horsepower and rpm.
    - m. Voltage at each connection.
    - n. Amperage for each phase.
    - o. Full-load amperage and service factor.
    - p. Seal type.
  
  2. Test Data (Indicated and Actual Values):
    - a. Static head in feet of head or psig.
    - b. Pump shutoff pressure in feet of head or psig.
    - c. Actual impeller size in inches.
    - d. Full-open flow rate in gpm.
    - e. Full-open pressure in feet of head or psig.
    - f. Final discharge pressure in feet of head or psig.
    - g. Final suction pressure in feet of head or psig.
    - h. Final total pressure in feet of head or psig.
    - i. Final water flow rate in gpm.
    - j. Voltage at each connection.
    - k. Amperage for each phase.
  
- M. Instrument Calibration Reports:
  1. Report Data:
    - a. Instrument type and make.
    - b. Serial number.



- c. Application.
- d. Dates of use.
- e. Dates of calibration.

### 3.18 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Engineer and Owner.
- B. Engineer or Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
  - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
  - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
  - 3. If the second verification also fails, Owner or Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

### 3.19 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593



## SECTION 230719 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes insulation for HVAC piping systems.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

## 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials, Type II for sheet materials.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Aeroflex USA.
    - b. Armacell LLC.
    - c. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. Knauf Insulation.
    - c. Owens Corning.
  - 2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
  - 3. 850 deg F.
  - 4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
  - 5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Ramco Insulation, Inc.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric: Solvent-based adhesive.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Aeroflex USA.
    - b. Armacell LLC.
    - c. K-Flex USA.
  - 2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
  - 3. Wet Flash Point: Below 0 deg F.
  - 4. Service Temperature Range: 40 to 200 deg F.
  - 5. Color: Black.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
- D. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.

## 2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Mon-Eco Industries, Inc.
  2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
  3. Service Temperature Range: 0 to 180 deg F.
  4. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
  2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
  3. Service Temperature Range: Minus 50 to plus 220 deg F.
  4. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Adhesive shall comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Vimasco Corporation.
  2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  3. Service Temperature Range: 0 to plus 180 deg F.
  4. Color: White.

## 2.6 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Pittsburgh Corning Corporation.
2. Permanently flexible, elastomeric sealant.
  - a. Service Temperature Range: Minus 150 to plus 250 deg F.
  - b. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Mon-Eco Industries, Inc.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

D. ASJ Flashing Sealants and PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

## 2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
  2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.



## 2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. Metal Jacket:

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

- a. Childers Brand; H. B. Fuller Construction Products.
- b. ITW Insulation Systems; Illinois Tool Works, Inc.
- c. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

- a. Sheet and roll stock ready for shop or field sizing.
- b. Finish and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.
- e. Factory-Fabricated Fitting Covers:
  - 1) Same material, finish, and thickness as jacket.
  - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
  - 3) Tee covers.
  - 4) Flange and union covers.
  - 5) End caps.
  - 6) Beveled collars.
  - 7) Valve covers.
  - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless Steel Jacket: ASTM A240/A240M.

- a. Sheet and roll stock ready for shop or field sizing.
- b. Material, finish, and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.
- e. Factory-Fabricated Fitting Covers:
  - 1) Same material, finish, and thickness as jacket.
  - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
  - 3) Tee covers.
  - 4) Flange and union covers.
  - 5) End caps.
  - 6) Beveled collars.
  - 7) Valve covers.

- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

## 2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. 3M Industrial Adhesives and Tapes Division.
    - b. Avery Dennison Corporation, Specialty Tapes Division.
    - c. Knauf Insulation.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## 2.10 SECUREMENTS

- A. Bands:
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.
    - b. RPR Products, Inc.
    - c. Childers Brand; H. B. Fuller Construction Products.
  2. Stainless Steel: ASTM A240/A240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
  3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. **Stainless Steel:** Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  2. **Carbon Steel:** Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
  - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
  2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

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

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.



### 3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

### 3.9 FINISHES

- A. Insulation with ASJ, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099100 "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
- B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

### 3.11 PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
  - 1. All Pipe Sizes:
    - a. Flexible Elastomeric: 1 inch thick.
- B. Heating- Water Supply and Return, 200 Deg F and Below:
  - 1. All Pipe Sizes::
    - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
- C. Refrigerant Suction and Hot-Gas Piping and Flexible Tubing:
  - 1. All Pipe Sizes:
    - a. Flexible Elastomeric: 1 inch thick.

3.12 FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Indoor Piping, Exposed:
  - 1. Aluminum, Smooth: 0.016 inch thick.
- D. Indoor Piping, Concealed:
  - 1. None.
- E. Outdoor Piping:
  - 1. Stainless Steel, Type 316, Smooth No. 2B Finish with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION 230719

## 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round ducts and fittings.
4. Double-wall round ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.

- B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

- B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.

7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

#### 1.4 DELEGATED-DESIGN SUBMITTAL

- A. Sheet metal thicknesses.
- B. Joint and seam construction and sealing.
- C. Reinforcement details and spacing.
- D. Materials, fabrication, assembly, and spacing of hangers and supports.
- E. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.
- F. Support details shown on the drawings are indicative and do not relieve the Contractor the design responsibilities indicated above.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Welding certificates.
- C. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and wind restraints shall withstand the effects of gravity and wind loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
- C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

### 2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
  - 1. Construct ducts of aluminum sheet metal unless otherwise indicated.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
  - 2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards -

Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. McGill AirFlow LLC.
  - 2. MKT Metal Manufacturing.
  - 3. Set Duct Manufacturing.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
  - 1. Construct ducts of sheet metal unless otherwise indicated.
  - 2. For ducts exposed to weather, construct outer duct of aluminium indicated by manufacturer to be suitable for outdoor installation.
- D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
  - 2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
  - 3. For exterior applications, all joints shall be welded.
- E. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  3. Coat insulation with antimicrobial coating.
  4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
- H. Inner Duct: Minimum 24-gauge solid aluminum sheet metal.

## 2.4 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Construct ducts of aluminum sheet metal unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
  2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- C. Factory- or Shop-Applied Antimicrobial Coating:
  - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
  - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
  - 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
  - 5. Shop-Applied Coating Color: Black.
  - 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- D. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; stainless steel.
- E. Tie Rods: Stainless steel, 1/4-inch-minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

## 2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
  - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  - 2. Tape Width: 3 inches.
  - 3. Sealant: Modified styrene acrylic.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.
  - 6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
  - 7. Service: Indoor and outdoor.
  - 8. Service Temperature: Minus 40 to plus 200 deg F.
  - 9. Substrate: Compatible with stainless steel, or aluminum.



10. Sealant shall have a VOC content of 420 g/L or less.
11. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Sealant shall have a VOC content of 420 g/L or less.
9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
10. Service: Indoor or outdoor.
11. Substrate: Compatible with stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Corrosive Environments and Outdoors: Type 316 Stainless Steel.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Duct Attachments: Coordinate with existing building construction, and submit proposed attachment method for approval.
- D. Trapeze and Riser Supports:
  - 1. Supports for Aluminum Ducts: Aluminum or stainless steel.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Where ducts are installed tight to the building structure, install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- J. Install fire dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.
- M. Elbows: Use long-radius elbows wherever they fit.
  - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
  - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.
- N. Branch Connections: Use lateral or conical branch connections.

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 DUCTWORK EXPOSED TO WEATHER

- A. All external joints are to be welded. Seal all openings to provide weatherproof construction.
- B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.
- C. Double Wall:
  - 1. Ductwork shall comply with requirements in "Double-Wall Rectangular Ducts and Fittings" Article.
  - 2. Ductwork outer wall shall be aluminum indicated by manufacturer to be suitable for outdoor installation.
  - 3. Provide interstitial insulation.

4. Provide solid aluminum liner.

### 3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  2. Outdoor, Supply-Air Ducts: Seal Class A.
  3. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
    - a. Exterior Supply Ducts with a Pressure Class of 2-Inch wg or Less: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
  - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
  - 5. Test for leaks before applying external insulation.
  - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  - 7. Give fourteen days' advance notice for testing.
- C. Duct system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.8 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use duct cleaning methodology as indicated in NADCA ACR.
- C. Use service openings for entry and inspection.
  - 1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
  - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

### 3.9 STARTUP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

### 3.10 DUCT SCHEDULE

- A. Fabricate ducts with aluminum sheet steel as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
  2. Interior and exterior Ducts: aluminum.
  - 3.
- B. Supply Ducts:
1. Ducts Connected to Constant-Volume Air-Handling Units PTB-MAU-01:
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: C.
    - c. SMACNA Leakage Class for Rectangular: 16.
- C. Intermediate Reinforcement:
- D. Double-Wall Duct Interstitial Insulation:
1. Exterior Supply-Air Ducts: 2 inches thick.
- E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
    - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      - 1) Radius-to Diameter Ratio: 1.5.
    - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
    - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- F. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm: Conical tap.
  - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113



## SECTION 233116 - NONMETAL DUCTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Thermoset FRP ducts and fittings.

- B. Related Sections:

- 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for nonmetal ducts.
- 2. Section 233113 "Metal Ducts" for single- and double-wall, rectangular and round ducts.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including duct thickness, joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "Thermoset FRP Duct Construction Manual" and performance requirements and design criteria indicated. Include the design and selection of flexible connectors, anchors, guides, and sliding supports to accommodate thermal expansion and contraction.

- 1. Static-Pressure Classes:

- a. Exhaust Ducts (Positive and Negative Pressure):  $\pm 20$ -inch wg.

- B. Delegated Duct Support Design: Design the duct hangers and supports to withstand the effects of gravity, wind loads, and thermal expansion loads within limits and under conditions indicated according to ASCE/SEI 7 and SMACNA's "Thermoset FRP Duct Construction Manual.

- 1. Exception: The 44" round foul air ductwork between the Preliminary Treatment Building and Gravity Thickeners are supported by structural bridge supports as shown on the structural drawings.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:

1. Thermoset FRP duct materials.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevation of top of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Hangers and supports, including methods for duct and building attachment, wind restraints, and vibration isolation.
11. Locations for duct accessories, including dampers, turning vanes, taps for pressure-temperature probes, taps for testing and balancing, flexible connectors, guides, anchors, and access doors.

C. Delegated-Design Submittal:

1. Duct materials and thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and wind restraints.
  - a. Support details shown on the drawings are indicative and do not relieve the Contractor the design responsibilities indicated above.
6. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation, for designing the ductwork.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Structural members to which duct will be attached.
3. Penetrations of smoke barriers and fire-rated construction.
4. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.

- b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.
- B. Welding certificates.
  - C. Field quality-control reports.
  - D. Proposed duct pressure testing plan.
  - E. Manufacture's witness test certification.

## 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
- C. NFPA Compliance:
  - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
  - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

## 1.7 COORDINATION

- A. Coordinate the location of duct joints and flanges to accommodate the construction sequencing requirements.

## PART 2 - PRODUCTS

### 2.1 THERMOSET FRP DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Perry Fiberglass Products, Inc.
  - 2. Spunstrand.
  - 3. Or equal.
- B. Duct and Fittings:
  - 1. Resin:

- a. Utilize resins that are suitable for a wastewater treatment plant environment. The following chemical/moisture/temperature conditions are expected to exist at various times in the exhaust air stream. Resins must be suitable for the following:
    - 1) Hydrogen sulfide – up to 200 ppm.
    - 2) Other compounds: VOC's, reduced sulfur compounds, amines, indole, skatole, and organic acids.
    - 3) Water vapor up to 100% RH.
    - 4) Temperature Range: 40°F to 95°F.
  - b. Utilize corrosion-resistant vinyl ester resin with fire retardant. Utilize resin that does not require additives such as antimony which detract from visual inspection or deplete the corrosion resistance. Provide a resin that yields a translucent laminate.
  - c. Manufacture duct with resin that complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to ASTM E84. Coat the ductwork with moisture-resistant intumescent paint if necessary to achieve the required rating.
2. Round Duct: Filament-wound.
  3. Rectangular Duct: Contact-molded hand layup.
  4. Duct Thickness:
    - a. Based on 1% deflection.
    - b. Based on 10:1 safety factor for pressure service and 5:1 safety factor for vacuum service.
    - c. Minimum Duct Thickness:
      - 1) 0-18 inch diameter : 0.250 inches
      - 2) 20-36 inch diameter: 0.375 inches
      - 3) 38-54 inch diameter: 0.500 inches
  5. Corrosion Barrier:
    - a. 20 mil chemical-resistant interior liner.
    - b. 80 mil interior layer of 1.5 oz/sf mat.
  6. Structural Layer: Type E filament winding glass or alternating layers of chopped strand mat and woven roving.
  7. Exterior Surface: Resin-rich gel coat with ultraviolet inhibitor.
  8. Joints: Butt-wrapped, bell and spigot, or flanged.
  9. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and joining method as duct.
  10. Rectangular Fittings: Flat sheet with fiberglass roving and resin-reinforced joints and seams.
- C. Fabrication:
1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction

- Manual," Chapter 7, "Requirements, and the manufacturer's recommendations. Seal all joints internally.
2. Fabricate 90-degree rectangular mitered elbows with turning vanes.
  3. Fabricate round elbows with a 1.5 radius-to-diameter ratio unless shown otherwise in the Drawings.
  4. Fabricate ducts with a laminated ring, angle, or lug to support vertical sections.
- D. Duct Finish:
1. Provide fabricated or painted white finish.
- E. Drains: Formed drain pockets with a minimum of NPS 1 threaded pipe connections.
- F. Flanged Connections:
1. FRP flanges with bolt holt pattern per ASTM D3982.
  2. Minimum flange thickness:  $\frac{3}{4}$  inch.
  3. Hardware: Type 316 stainless steel.
  4. Gasket material: EPDM.
  5. Gasket thickness:  $\frac{1}{8}$  inch.

## 2.2 RUBBER FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daniel Company.
  2. General Rubber.
  3. Holz.
  4. Mercer.
  5. Proco Products.
  6. Or equal.
- B. Elastomer Material: Neoprene, EPDM, or Hypalon. Resistant to UV and H<sub>2</sub>S.
- C. Flange:
1. Material: Type 316 stainless steel or FRP.
  2. Pre-punched to match adjacent duct or equipment.
- D. Pressure rating: 5 psig positive, 5 psig negative.
- E. Band and hardware: Type 316 stainless steel.
- F. Profile: Single or multiple arched. As determined by the FRP duct supplier.
- G. Axial extension, axial contraction, and lateral offset rating: As determined by the FRP duct supplier.

## 2.3 HANGERS AND SUPPORTS

- A. Hanger and support materials: Type 316 Stainless Steel.
- B. Design hangers and supports based on 10-foot maximum spacing, and in compliance with the ductwork designer/manufacturer's requirements.
- C. Hanger Rods: All-thread rods, nuts, and washers.
- D. Trapeze Hangers: Stainless steel or aluminum shapes.
- E. Welded Wall Brackets: MSS SP-58 Type 32 or Type 33.
- F. Horizontal Duct Saddles: 180 degree saddle on the bottom half of the duct with integral stiffeners and baseplate. Include elastomeric liner between the saddle and the duct. Include banding on top of the duct.
- G. Horizontal Duct Hanger: 360 degree strap with integral bracket for hanger rod attachment. Include elastomeric liner between the strap and the duct.
- H. Horizontal Duct Hanger: 180 degree strap with Clevis hanger for hanger rod attachment. Include elastomeric liner between the strap and the duct.
- I. Vertical Duct Riser Support: 360 degree band with integral brackets or tabs to attach to the adjacent surface. Include elastomeric liner between the band and the duct.
- J. Suspended Vertical Duct Riser Support: 360 degree band with integral brackets for hanger rod attachment. Include elastomeric liner between the band and the duct.
- K. Horizontal Duct Anchor: 360 degree band with integral baseplate that is suitable for welding to the structural steel support. Include elastomeric liner between the band and the duct.
- L. Provide 3" (min.) wide bands, straps, and saddles with the supports to distribute the load to the duct.

## 2.4 FASTENER SYSTEMS

- A. Fastener materials: Type 316 Stainless Steel.
- B. Coordinate fastener types with the existing building construction. Submit proposed fastener types for each application for approval prior to installation..

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

- B. Install ducts in maximum practical lengths with fewest possible joints.
- C. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- D. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- F. Where ducts are installed tight to structure, install ducts with a clearance of 1 inch.
- G. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct with Type 316 stainless steel sheet metal flanges. Overlap openings on four sides by at least 1-1/2 inches.
- H. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- I. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials.
- J. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
- B. Building Attachments: Coordinate building attachments with the existing structure. Submit proposed attachment method for approval prior to installation.

### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Submit testing plan for field testing ductwork.
  - 3. Test the following systems:

- a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
  4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give fourteen days' advance notice for testing.
    - a. Maximum design pressure: +/- 20 inches water gauge.
    - b. Test ductwork for both positive and negative pressure.
  6. Manufacturer's representative and Owner's representative to witness testing.
- C. Duct system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.4 DUCT CLEANING

- A. Clean duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
  2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
  2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.



3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
2. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.
3. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide drainage and cleanup for wash-down procedures.
6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.5 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 233116



## 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Manual volume dampers.
  - 2. Control dampers.
  - 3. Turning vanes.
  - 4. Remote damper operators.
  - 5. Duct-mounted access doors.
  - 6. Flexible connectors.
  - 7. Duct accessory hardware.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
  - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a. Special fittings.
    - b. Manual volume damper installations.
    - c. Control-damper installations.
    - d. Wiring Diagrams: For power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

- B. Source quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

### PART 2 - PRODUCTS

#### 2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

#### 2.2 MATERIALS

- A. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- B. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
- C. Reinforcement Shapes and Plates: Aluminum or stainless steel materials for aluminum.
- D. Tie Rods: Stainless steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

#### 2.3 MANUAL VOLUME DAMPERS

- A. Low-Leakage, Aluminum, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Greenheck Fan Corporation.
    - b. Nailor Industries Inc.

c. Ruskin Company

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames: Hat, U, or Angle-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
  - d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
7. Blade Axles: Stainless steel.
8. Bearings:
  - a. Molded synthetic.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Vinyl.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Aluminum.
12. Accessories:
  - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

B. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.4 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Greenheck Fan Corporation.
  2. Nailor Industries Inc.
  3. Ruskin Company.
- B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat U, and Angle shaped.
  2. Aluminum or stainless steel.
  3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 6 inches.
  2. Parallel- and opposed-blade design.
  3. Aluminum.
  4. 0.0747-inch-thick dual skin.
  5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; stainless steel or nonferrous metal; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
1. Molded synthetic.
  2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  3. Thrust bearings at each end of every blade.

## 2.5 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Ruskin Company.
  2. Greenheck Fan Corporation.
  3. Pottorff.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades inside airstream or curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-

formed, galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

- F. Mounting Sleeve: Factory- or field-installed, stainless steel; gauge in accordance with UL listing.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, stainless sheet steel; gauge in accordance with UL listing.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

## 2.6 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Aero-Dyne Sound Control Co.
  - 2. Ductmate Industries, Inc.
  - 3. Duro Dyne Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall.

## 2.7 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Arrow United Industries.
  - 2. Ductmate Industries, Inc.
  - 3. Duro Dyne Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
  - 1. Door:

- a. Double wall, rectangular.
  - b. Aluminum or stainless steel sheet metal with insulation fill and thickness as indicated for duct pressure class.
  - c. Vision panel.
  - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
  - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Aluminum or stainless sheet steel, with bend-over tabs and foam gaskets.
  3. Number of Hinges and Locks:
    - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    - b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
    - c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.

## 2.8 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Ventfabrics, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  1. Minimum Weight: 24 oz./sq. yd..
  2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  3. Service Temperature: Minus 50 to plus 250 deg F.

## 2.9 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.



## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. Control devices requiring inspection.
  - 2. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 by 5 inches.
  - 2. Two-Hand Access: 12 by 6 inches.
  - 3. Head and Hand Access: 18 by 10 inches.
  - 4. Head and Shoulders Access: 21 by 14 inches.
  - 5. Body Access: 25 by 14 inches.
  - 6. Body plus Ladder Access: 25 by 17 inches.
- J. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment.
- L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

- M. Install duct test holes where required for testing and balancing purposes.
- N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Operate dampers to verify full range of movement.
  - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
  - 3. Inspect turning vanes for proper and secure installation.
  - 4. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

## SECTION 233416 - CENTRIFUGAL HVAC FANS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Utility set fans.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
- 2. Rated capacities, operating characteristics, and furnished specialties, and accessories.
- 3. Certified fan performance curves with system operating conditions indicated.
- 4. Certified fan sound-power ratings.
- 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
- 6. Material thickness and finishes, including color charts.
- 7. Dampers, including housings, linkages, and operators.

- B. Shop Drawings:

- 1. Include plans, elevations, sections, and attachment details.
- 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 3. Include diagrams for power, signal, and control wiring.
- 4. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
- 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor basis, rails, and frames for equipment mounting.

#### 1.4 DELEGATED DESIGN SUBMITTALS

- A. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and wind restrains and for designing vibration isolation bases.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency, operation, and maintenance manuals with replacement parts listing.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Belts: Three sets for each belt-driven unit.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. AMCA Compliance:
  1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolators and supports.
- C. Refer to the Schedule on the Drawings for Performance Data, Capacities, and Characteristics.

#### 2.2 UTILITY SET FANS

- A. Description:
  1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- B. Housings:
  1. Housing Material: Aluminum.

2. Housing Coating: See schedule.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of eight discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: Aluminum.
  - a. Spark-Resistant Construction: Classified according to AMCA 99, Type A.
3. Wheel and Blade Coating: See schedule.
4. Backward-Inclined Airfoil Blades:
  - a. Aerodynamic design.
  - b. Heavy backplate.
  - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
5. Backward-Inclined Curved Blades:
  - a. Curved design.
  - b. Heavy backplate.
  - c. Single-thickness blades continuously welded at tip flange and backplate.
6. Backward-Inclined Flat Blades:
  - a. Flat design.
  - b. Heavy backplate.
  - c. Single-thickness blades continuously welded at tip flange and backplate.
7. Forward-Curved Blades:
  - a. Curved design.
  - b. Heavy backplate.
  - c. Single-thickness blades continuously welded or riveted at tip flange and backplate.

D. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

E. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast iron pillow block housing.
2. Ball-Bearing Rating Life: ABMA 9, L(10) of 80,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L(10) of 80,000 hours.

4. Extend grease fitting to accessible location outside of unit.

F. Belt Drive:

1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," 0.146 inch-thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

G. Motor Enclosure: Explosion-proof.

H. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Outlet Screens: Removable wire mesh.
8. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
10. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
11. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
12. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
13. Grease Collection Trough and Receiver: For restaurant exhaust application.
14. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 400593.23 "Low Voltage Motor Requirements for Process Equipment."

- B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

## 2.4 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Compliance: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311 and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify fans according to AMCA 99.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF CENTRIFUGAL HVAC FANS

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
  - 1. Install floor- or roof-mounted centrifugal fans on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- E. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- F. Install units with clearances for service and maintenance.
- G. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.2 DUCTWORK AND PIPING CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.

### 3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
  - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

### 3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Tests and Inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that there is adequate maintenance and access space.
  - 4. Verify that cleaning and adjusting are complete.



5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  6. Adjust belt tension.
  7. Adjust damper linkages for proper damper operation.
  8. Verify lubrication for bearings and other moving parts.
  9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  10. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
  11. Remove and replace malfunctioning units and retest as specified above.
- E. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416



## 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Centrifugal ventilators - roof upblast.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
  - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
  - 3. Certified fan performance curves with system operating conditions indicated.
  - 4. Certified fan sound-power ratings.
  - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 6. Material thickness and finishes, including color charts.
  - 7. Dampers, including housings, linkages, and operators.
  - 8. Prefabricated roof curbs.
  - 9. Fan speed controllers.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements and for designing wind restraints.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency, operation, and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Belts: Three sets for each belt-driven unit.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wind restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Refer to the Schedules on the Drawings for Performance Data, Capacities, and Characteristics:

#### 2.2 CENTRIFUGAL VENTILATORS - ROOF UPBLAST

- A. Configuration: Centrifugal roof upblast ventilator.
- B. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
  - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades; sparkproof construction.
- D. Belt Drives:
  - 1. Resiliently mounted to housing.
  - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.

4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
6. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Spark-resistant, all-aluminum wheel construction.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 400593.23 "Low Voltage Motor Requirements for Process Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## 2.4 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
  - 1. Install power ventilators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

### 3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
  - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

### 3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that there is adequate maintenance and access space.
  - 4. Verify that cleaning and adjusting are complete.
  - 5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 6. Adjust belt tension.
  - 7. Adjust damper linkages for proper damper operation.
  - 8. Verify lubrication for bearings and other moving parts.
  - 9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  - 10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 11. Shut unit down and reconnect automatic temperature-control operators.
  - 12. Remove and replace malfunctioning units and retest as specified above.
- D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423



## SECTION 233713.23 - REGISTERS AND GRILLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Adjustable blade face registers.

- B. Related Requirements:

- 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

- B. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Smallest size register and grille indicated.

- C. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Smallest size register and grille indicated.

### PART 2 - PRODUCTS

#### 2.1 REGISTERS

- A. Supply Registers (SR) - Adjustable Blade Face

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. METALAIRE, Inc.

- b. Price Industries.
- c. Titus.
  
- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white.
- 4. Face Blade Arrangement: Horizontal and Vertical spaced 3 inches apart.
- 5. Core Construction: Integral.
- 6. Frame: 1-1/4 inches wide.
- 7. Mounting: Countersunk screw.
- 8. Damper Type: Adjustable opposed blade.
- 9. Accessories:
  - a. Front-blade gang operator.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Engineer for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

#### 3.3 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

## SECTION 237423.16 - PACKAGED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

### 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.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete."
  - 2. Section 230593 "Testing, Adjusting, and Balancing for HVAC."
  - 3. Section 233113 "Metal Ducts."
  - 4. Section 233300 "Air Duct Accessories."
  - 5. Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  - 6. Section 260523 "Control-Voltage Electrical Power Cables."
  - 7. Section 260526 "Grounding and Bonding for Electrical Systems."
  - 8. Section 400593.23 "Low Voltage Motor Requirements for Process Equipment."

#### 1.2 SUMMARY

- A. Section includes outdoor, heating water, heating-only, makeup air units, including the following components:
  - 1. Casings.
  - 2. Outdoor-air intake hood.
  - 3. Roof curbs.
  - 4. Fans, drives, and motors.
  - 5. Air filtration.
  - 6. Dampers.
  - 7. Heating Water Heating Coil.
  - 8. Unit control panel.
  - 9. Controls.
  - 10. Accessories.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each outdoor, indirect, gas-fired, heating-only, makeup air unit.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Include unit dimensions and weight.
  - 4. Fans:

- a. Include certified fan-performance curves with system operating conditions indicated.
  - b. Include certified fan-sound power ratings.
  - c. Include fan construction and accessories.
  - d. Include motor ratings, electrical characteristics, and motor accessories.
5. Include filters with performance characteristics.
  6. Include heating water heating coil with performance characteristics.
  7. Include dampers, including housings, linkages, and operators.
- B. Shop Drawings: For each outdoor, heating water heating and ventilating unit.
1. Include plans, elevations, sections, and mounting attachment details.
  2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Detail fabrication and assembly of heating water heating and ventilating units, as well as procedures and diagrams.
  4. Include diagrams for power, signal, and control wiring.

#### 1.4 DELEGATED DESIGN SUBMITTALS

- A. Delegated Design Submittal: For roof mounted unit supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Sample Warranty: For manufacturer's warranty.
- C. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- D. Startup service reports.
- E. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For indirect, gas-fired, makeup air units to include in emergency, operation, and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: Three sets for each unit.
  - 2. Gaskets: Three sets for each access door.
  - 3. Fan Belts: Three sets for each unit.

#### 1.8 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of heating water heating and ventilating units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than one year from date of Substantial Completion.
  - 2. Warranty Period for Heat Exchangers: Not less than five years from date of Substantial Completion.
  - 3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wind restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

## 2.2 CAPACITIES AND CHARACTERISTICS

- A. Refer to the Schedules on the Drawings for Performance Data, Capacities, and Characteristics.

## 2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. Greenheck Fan Corporation.
  2. Modine Manufacturing Company.

## 2.4 UNIT CASINGS

- A. General Fabrication Requirements for Casings:
  1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
  2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
  3. Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
- B. Configuration: Horizontal unit with horizontal discharge for roof-mounting on concrete-base installation.
- C. Double-Wall Construction:
  1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick, with manufacturer's corrosion resistance coating. Refer to the Schedules on the Drawings for coating type.
  2. Inside Casing Wall:
    - a. Inside Casing, All Other Sections: Galvanized steel solid steel.
  3. Floor Plate: Galvanized steel, minimum 18 gauge thick.
  4. Casing Insulation:
    - a. Materials: Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071.
    - b. Casing Panel R-Value: Minimum 6.
    - c. Insulation Thickness: 1 inch.
    - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.
  5. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Panels and Doors:

1. Panels:

- a. Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.
- b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
- c. Gasket: Neoprene, applied around entire perimeters of panel frames.
- d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

2. Doors:

- a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
- b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
- c. Gasket: Neoprene, applied around entire perimeters of panel frames.
- d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

3. Locations and Applications:

- a. Fan Section: Doors.
- b. Access Section: Doors.
- c. Heating Water Coil Section: Doors.
- d. Damper Section: Doors.
- e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
- f. Mixing Section: Doors.

2.5 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Filter: Aluminum, 1 inch cleanable.
- E. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.6 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailers; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
    - a. Materials: ASTM C 1071, Type I or Type II.
    - b. Thickness: 1 inch.
  2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
    - a. Liner Adhesive: Comply with ASTM C 916, Type I.
    - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
    - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- B. Curb Height: 16 inches.
- C. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements on the Structural Drawings for wind-load requirements.

## 2.7 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Fans: Centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.
  1. Shafts: With field-adjustable alignment.
  2. Shaft Bearings: Heavy-duty, self-aligning, permanently lubricated ball bearings with an L50 rated life of 100,000 hours according to ABMA 9.
  3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
  4. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
  5. Shaft Lubrication Lines: Extended to a location outside the casing.
  6. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, galvanized-steel sheet.
    - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drives: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.



1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
2. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch-thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

D. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 400593.23 "Low Voltage Motor Requirements for Process Equipment."
2. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure: Totally enclosed, fan cooled.
4. Efficiency: Premium efficient as defined in NEMA MG 1.
5. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

## 2.8 AIR FILTRATION

A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

B. Cleanable Filters:

1. Cleanable metal mesh.

C. Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel track.
  - a. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

## 2.9 DAMPERS

- A. Outdoor Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in parallel-blade arrangement with

zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.

B. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
  - a. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  - b. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
5. Size dampers for running torque calculated as follows:
  - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
  - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
  - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
  - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
  - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
  - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
6. Coupling: V-bolt and V-shaped, toothed cradle.
7. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
8. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
9. Power Requirements (Two-Position Spring Return): 24 V dc.
10. Temperature Rating: Minus 22 to plus 122 deg F.
11. Run Time: 12 seconds open, 5 seconds closed.

2.10 HEATING-WATER HEATING COIL

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: Manufacturer's standard material.
- C. Tube Material: Copper.
- D. Tube Header Material: Manufacturer's standard material.
- E. Fin Material: Aluminum.

- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Coating: Corrosion-resistant coating after assembly.
- I. Tube Thickness: Manufacturer's Standard.
- J. Headers: Cast iron with cleaning plugs and drain and air vent tappings extended to exterior of unit.

## 2.11 UNIT CONTROL PANEL

- A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
- B. Control Panel: Surface-mounted remote panel, with engraved plastic cover and the following lights and switches:
  - 1. On-off fan switch.
  - 2. Heat-vent-off switch.
  - 3. Supply-fan operation indicating light.
  - 4. Heating operation indicating light.
  - 5. Thermostat.
  - 6. Damper position potentiometer.
  - 7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
  - 8. Safety-lockout indicating light.
  - 9. Enclosure: NEMA 250, Type 4X.

## 2.12 CONTROLS

- A. Refer to the Control Diagrams on the Drawings for the Sequence of Operations.
- B. Control Devices:
  - 1. Discharge Air Temperature Sensor.
  - 2. Outdoor Air Temperature Sensor.
  - 3. Remote Override Thermostat: Adjustable room thermostat without temperature readout.
  - 4. Ionization-Type Smoke Detectors:
    - a. 24-V dc, nominal.
    - b. Self-restoring.
    - c. Plug-in arrangement.
    - d. Integral visual-indicating light.
    - e. Sensitivity that can be tested and adjusted in place after installation.
    - f. Integral addressable module.
    - g. Remote controllability.
    - h. Responsive to both visible and invisible products of combustion.
    - i. Self-compensating for changes in environmental conditions.

- j. Weather tight cover.
  - k. Remote test, alarm, reset station.
- C. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
- D. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
- E. Temperature Control:
- 1. Heating-Water Coil Controls: Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to modulate factory- furnished coil control valve to maintain temperature.
    - a. Heating-Water Coil Controls: Space-overrode thermostat with temperature adjustment to modulate factory- furnished coil control valve to maintain temperature.
- F. Integral Smoke Alarm: Smoke detector installed in supply air shall stop fans when the presence of smoke is detected.

## 2.13 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Coil guards of painted, galvanized-steel wire.

## 2.14 MATERIALS

- A. Steel:
  - 1. ASTM A36/A36M for carbon structural steel.
  - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
  - 1. Manufacturer's standard grade for casing.
  - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.
- D. Examine roofs for suitable conditions where RTUs will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. **Roof Curb:** Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems" or AHRI Guideline B. Install units on curbs. Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment.
- B. **Unit Support:** Install unit level on structural curbs. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of curbs with actual equipment provided.
- C. **Unit Support:** Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- D. Install controls and equipment shipped by manufacturer for field installation with heating water heating and ventilating units.

### 3.3 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
  - 1. **Hydronic Piping Connections:**
    - a. Install shutoff valve and union or flange on each supply connection and install balancing valve and union or flange on each return connection.
- B. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

### 3.4 DUCTWORK CONNECTIONS

- A. Duct Connections: Connect supply ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

### 3.5 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
  - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

### 3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Inspect for visible damage to burner combustion chamber.
  - 2. Inspect casing insulation for integrity, moisture content, and adhesion.
  - 3. Verify that shipping, blocking, and bracing are removed.
  - 4. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete.
  - 5. Verify that clearances have been provided for servicing.
  - 6. Verify that controls are connected and operable.
  - 7. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
  - 8. Verify that labels are clearly visible.

9. Verify that filters are installed.
10. Inspect and adjust vibration isolators.
11. Verify that outdoor- open and close, and maintain minimum outdoor-air setting.
12. Verify bearing lubrication.
13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. Calibrate thermostats.
5. Adjust and inspect high-temperature limits.
6. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
7. Inspect controls for correct sequencing of heating, , and normal and emergency shutdown.
8. Measure and record airflow. Plot fan volumes on fan curve.
9. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
10. Measure and record motor electrical values for voltage and amperage.
11. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:
  - a. High-limit heat.
  - b. Alarms.
12. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
13. Verify outdoor-air damper operation.

### 3.8 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.9 CLEANING

- A. After completing system installation testing, adjusting, and balancing and after completing startup service:
  1. Clean air-handling units internally to remove foreign material, construction dirt and dust.

2. Clean fan wheels, cabinets, dampers, coils, and filter housings.
3. Install new, clean filters.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 237423.16



## SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Removal of existing electrical equipment, wiring, and conduit in areas to be modified; removal of designated construction; dismantling, cutting and alterations for completion of the Work.
2. Disposal of materials.
3. Storage of removed materials.
4. Identification of utilities.
5. Salvaged items.
6. Protection of items to remain as indicated on Drawings.
7. Relocate existing equipment to accommodate construction.

- B. Related Sections:

1. Section 024119 "Selective Demolition" for removal of designated building equipment and construction.

#### 1.3 ACTION SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.
- B. Shop Drawings: Indicate removal sequence; location and construction of temporary work. Describe demolition removal procedures and schedule.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of capped conduits and equipment abandoned in place.

#### 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with Arlington County standards.

## 1.6 SEQUENCING

- A. Section 011000 “Summary” for requirements for sequencing.
- B. Refer to Specification Section 018100 “Maintenance of Plant Operation and Sequence of Construction” for additional requirements.

## 1.7 SCHEDULING

- A. Schedule work to coincide with new construction.
- B. Cease operations immediately when structure appears to be in danger and notify Engineer. Do not resume operations until directed.

## 1.8 COORDINATION

- A. Section 013000 “Administrative Requirements” for requirements for coordination.
- B. Conduct demolition to minimize interference with adjacent and occupied building areas.
- C. Coordinate demolition work with other trades and the Owner.
- D. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.
- E. Equipment scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition.
- F. Shut-down Periods:
  - 1. Arrange timing of shut-down periods of in service panels with Owner. Do not shut down any utility without prior written approval.
  - 2. Keep shut-down period to minimum or use intermittent period as directed by the Owner.
  - 3. Maintain life-safety systems in full operation in occupied facilities, or provide notice minimum 2 weeks in advance.
- G. Identify salvage items in cooperation with Owner.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.
- B. Verify termination points for demolished services.

### 3.2 PREPARATION

- A. Erect, and maintain temporary safeguards, including warning signs, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.
- B. Temporary egress signage and emergency lighting

### 3.3 REMOVAL AND DISPOSAL OF LEGALLY REGULATED MATERIALS

- A. Material and equipment indicated to be removed and disposed of will become the Contractor's property. Dispose of material and equipment offsite, unless otherwise directed by the Owner. Provide the Owner with a receipt indicating the acceptable disposal of any legally regulated materials or equipment.
- B. Assume that the ballasts in each existing lighting fixture contain PCB's, unless specifically marked with a label indicating "No PCBs." Remove ballasts from each lighting fixture and pack them in accordance with EPA PCB regulations. Ship ballasts in approved containers to an EPA approved recycling facility; pay all shipping, packaging and recycling costs.
- C. Remove, package, ship and dispose of PCBs, mercury and PCB/mercury contaminated equipment, in accordance with all State and Federal regulations. Retain the services of a firm licensed and regularly engaged in the removal of PCBs and PCB contaminated equipment. Retain a firm licensed in the State or States in which the contaminated material is handled, shipped and disposed of. Pay all fees associated with the removal of the contaminated material and equipment. Submit documentation indicating acceptable disposal.
- D. If PCB's or mercury contaminated equipment are discovered that were not identified; cease work on or about the equipment and notify the Engineer immediately.

### 3.4 DEMOLITION

- A. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.
- B. Maintain existing area classifications as shown on the drawings and in accordance to NEC Article 500.
- C. All energy sources shall be disconnected, locked and tagged out before work begins. Work on energized equipment by special permission and approved by the Owner in advance.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.
- F. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

- G. Reconnect equipment being disturbed by renovation work and required for continuous service to the nearest available and suitable source.
- H. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.
- I. Install temporary wiring and connections to maintain existing systems in service during construction.
- J. Perform work on energized equipment or circuits with experienced and trained personnel.
- K. Remove, relocate, and extend existing installations to accommodate new construction.
- L. Repair adjacent construction and finishes damaged during demolition and extension work.
- M. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finishes. Cut embedded support elements flush with walls and floors.
- N. Clean and repair existing equipment to remain.
- O. Protect and retain power to existing active equipment remaining.
- P. Cap abandoned empty conduit at both ends.

### 3.5 EXISTING PANELBOARDS

- A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.
- B. Tag unused circuits as spare.
- C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.
- D. Remove existing wire no longer in use from panel to equipment.
- E. Provide new updated typewritten directories where more than three circuits have been modified or rewired. Handwritten directories are not acceptable.

### 3.6 SALVAGE ITEMS

- A. Remove and protect items indicated on Drawings to be salvaged and turn over to Owner
- B. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed.

3.7 REUSABLE ELECTRICAL EQUIPMENT

- A. Carefully remove equipment, materials, or fixtures which are to be reused.
- B. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.

3.8 CLEANING

- A. Remove all demolished materials from the site and legally dispose of unless specifically called for to be saved and turned over to the Owner.
- B. Keep workplace neat.

END OF SECTION 260505



## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Copper building wire rated 600 V or less.
- 2. Connectors, splices, and terminations rated 600 V and less.

- B. Related Requirements:

- 1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

#### 1.3 DEFINITIONS

- A. RoHS: Restriction of Hazardous Substances.
- B. VFC: Variable-frequency controller.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## PART 2 - PRODUCTS

### 2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Encore Wire Corporation.
  - 2. General Cable Technologies Corporation.
  - 3. Okonite Company (The).
  - 4. Southwire Company.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
  - 1. Type THWN-2: Comply with UL 83.
  - 2. Type XHHW-2: Comply with UL 44.
- F. Shield:
  - 1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

### 2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Electrical Products.
  - 2. Ideal Industries, Inc.
  - 3. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 4. Service Wire Co.
  - 5. TE Connectivity Ltd.



6. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
  1. Material: Copper.
  2. Type: One hole with standard barrels.
  3. Termination: Compression.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Stranded copper.
- B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type XHHW-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. .
- D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- E. VFC Output Circuits: Type TC-ER cable with braided shield.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.

### 3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

### 3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors and conductors feeding all equipment installed or modified for this project.
  - 2. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    - b. Test bolted connections for high resistance using one of the following:

- 1) A low-resistance ohmmeter.
  - 2) Calibrated torque wrench.
  - 3) Thermographic survey.
- c. Inspect compression-applied connectors for correct cable match and indentation.
  - d. Inspect for correct identification.
  - e. Inspect cable jacket and condition.
  - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
  - g. Continuity test on each conductor and cable.
  - h. Uniform resistance of parallel conductors.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
1. Procedures used.
  2. Results that comply with requirements.
  3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519



## SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER 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. Section Includes:
  - 1. Category 6 balanced twisted pair cable.
  - 2. Category 6a balanced twisted pair cable.
  - 3. Instrumentation cable
  - 4. Low-voltage control cabling.
  - 5. Control-circuit conductors.
  - 6. Identification products.

#### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
  - 1. Flame Travel Distance: 60 inches or less.
  - 2. Peak Optical Smoke Density: 0.5 or less.
  - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

### 2.2 CATEGORY 6 BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M.
  - 2. Belden CDT Networking Division/NORDX.
  - 3. Draka USA.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).

- F. Cable Rating: Riser.
- G. Jacket: Gray thermoplastic.

### 2.3 CATEGORY 6a BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- B. <Double click here to find, evaluate, and insert list of manufacturers and products>.
- C. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).
- F. Cable Rating: Riser.
- G. Jacket: Blue thermoplastic.

### 2.4 INSTRUMENTATION CABLE

- A. Paired Cable:
  - 1. One pair, No. 16 AWG, stranded and twisted on 2-in lay.
  - 2. PVC insulation, 600V rating, 105 degrees C rating.
  - 3. Shielded: 100 percent mylar tape with drain wire.
  - 4. PVC jacket with UL subject 277, UL 1581 and manufacturer's identification.
  - 5. Manufacturers: Belden, or equal.

### 2.5 CONTROL-CIRCUIT CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Encore Wire Corporation.
  - 2. General Cable; General Cable Corporation.
  - 3. Southwire Company.
- B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

### 2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.

- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Test cables on receipt at Project site.
  - 1. Test each pair of twisted pair cable for open and short circuits.

#### 3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.

#### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C Series of standards.
  - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
  - 5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
  - 6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
  - 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.



9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.4 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

### 3.5 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
  1. Class 1 remote-control and signal circuits; No 14 AWG.
  2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.

### 3.6 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

### 3.7 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 260523



## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency and testing agency's field supervisor.
- B. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

### PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

#### 2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Burndy; Part of Hubbell Electrical Systems.

2. O-Z/Gedney; a brand of Emerson Industrial Automation.
3. Thomas & Betts Corporation; A Member of the ABB Group.

## 2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  1. Stranded Conductors: ASTM B 8.
  2. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  5. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

## 2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

### 3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Single-phase motor and appliance branch circuits.
  - 4. Three-phase motor and appliance branch circuits.
  - 5. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  - 6. All process mechanical equipment.
- C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

### 3.3 INSTALLATION

- A. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.

3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

#### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
  1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

END OF SECTION 260526



## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.
3. Conduit and cable support devices.
4. Support for conductors in vertical conduit.
5. Structural steel for fabricated supports and restraints.
6. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
7. Fabricated metal equipment support assemblies.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
  - a. Slotted support systems, hardware, and accessories.
  - b. Clamps.
  - c. Hangers.
  - d. Sockets.
  - e. Eye nuts.
  - f. Fasteners.
  - g. Anchors.
  - h. Saddles.
  - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.

3. Equipment supports.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. In dry indoor areas, hangers, rods, backplates, beam clamps, channel, etc. shall be galvanized iron or steel.
- B. PVC coated steel channel with stainless steel hardware shall be used in areas designated "WET" or "CORROSIVE" on the Drawings and in outdoor locations. Fiberglass channel shall be resistant to the chemicals present in the area in which it is used.
- C. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be galvanized zinc plated steel except that stainless steel shall be used in areas designated as "WET" or "CORROSIVE" on the Drawings.
- D. Conduit Supports:
  - 1. Trapezes:
    - a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be galvanized steel.
    - b. PVC coated steel beams, channels, struts or fiberglass beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels shall be resistant to the chemicals present in the area in which it is used.
  - 2. Flush Mounted Supports:
    - a. In dry indoor areas, channels, struts, accessories and components shall be galvanized steel.
    - b. PVC coated steel channels, struts or fiberglass channels, struts with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels, struts shall be resistant to the chemicals present in the area in which it is used.
  - 3. Conduit Racks:
    - a. In dry indoor areas, conduit racks, accessories and components shall be galvanized steel.
    - b. PVC coated steel conduit racks or fiberglass conduit racks with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels shall be resistant to the chemicals present in the area in which it is used.
  - 4. Conduit Hangers:

- a. In dry indoor areas, conduit clamps, rods, beam clamps, bracing, accessories and components shall be galvanized steel.
  - b. Stainless steel conduit clamps, rods, beam clamps, bracing, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.
- E. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flex-Strut Inc.
    - b. Thomas & Betts Corporation; A Member of the ABB Group.
    - c. Unistrut; Part of Atkore International.
  2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Material for Channel, Fittings, and Accessories: Stainless steel, Type 316.
  4. Channel Width: Selected for applicable load criteria.
  5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
- F. Conduit and Cable Support Devices: Stainless-steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- G. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- H. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- I. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti, Inc.
      - 2) MKT Fastening, LLC.
      - 3) Simpson Strong-Tie Co., Inc.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) B-line, an Eaton business.
  - 2) Hilti, Inc.
  - 3) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  1. NECA 1.
  2. NECA 101
- B. Wall and Floor Slab Opening Seals:
  1. Wall and floor slab openings shall be sealed with a UL approved expanding material which equals or exceeds the fire rating of the wall or floor construction as manufactured by the Thomas & Betts Corp., or equal.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 2. To Existing Concrete: Expansion anchor fasteners.
  - 3. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
  - 4. To Light Steel: Sheet metal screws.
  - 5. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

### 3.3 PAINTING

- A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529



## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Metal conduits and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface raceways.
4. Boxes, enclosures, and cabinets.

- B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 260529 "Hangers and Supports for Electrical Systems"

#### 1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  1. Structural members in paths of conduit groups with common supports.
  2. Process mechanical items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.

- C. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Outdoor Locations, Above Grade: Provide PVC-coated rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.
- C. Wet and Damp Locations: Provide PVC-coated rigid steel conduit Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- D. Concealed Dry Locations: Provide rigid steel conduit in non-process areas. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- E. Exposed Dry Locations: Provide rigid steel conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- F. Corrosive Locations: Provide PVC Coated Rigid Steel Conduit. Provide PVC coated cast metal boxes.
- G. Hazardous/Explosion Proof Locations (Class 1, Group D, Division 1): Provide PVC-coated Rigid Steel Conduit. Provide cast iron boxes.

### 2.2 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; a part of Atkore International.
    - b. O-Z/Gedney; a brand of Emerson Industrial Automation.
    - c. Thomas & Betts Corporation; A Member of the ABB Group.
    - d. Western Tube and Conduit Corporation.
    - e. Wheatland Tube Company.
  - 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. GRC: Comply with ANSI C80.1 and UL 6.
  - 4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - a. Comply with NEMA RN 1.



- b. Coating Thickness: 0.040 inch, minimum.
  5. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- B. Metal Fittings:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; a part of Atkore International.
    - b. O-Z/Gedney; a brand of Emerson Industrial Automation.
    - c. Thomas & Betts Corporation; A Member of the ABB Group.
    - d. Western Tube and Conduit Corporation.
    - e. Wheatland Tube Company.
  2. Comply with NEMA FB 1 and UL 514B.
  3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  4. Fittings, General: Listed and labeled for type of conduit, location, and use.
  5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
  6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints. Coating shall be on both inside and outside conduit surfaces.
- C. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.3 HAZARDOUS (CLASSIFIED) LOCATION BOXES

- A. Design explosion-proof boxes for Class 1, Group D, Division 2 hazardous locations. Provide cast iron with cadmium-zinc or hot-dipped galvanized finish, stainless steel or hot-dipped galvanized bolts;
  1. Manufacturer: Provide products by one of the following:
    - a. "Type EJB," by the Crouse-Hinds Company.
    - b. Appleton Electric Co.
    - c. The Pyle-National Co.
    - d. Or equal.
- B. Design explosion-proof boxes for Class 1, Group D, Division 2 hazardous locations, provided with O-ring seals to meet NEMA 7 requirements.
  1. Boxes and Covers: Aluminum, with stainless steel hinges and stainless steel bolts.
  2. Manufacturer: Provide products by one of the following:

- a. "Type EJB-N4," by the Crouse-Hinds Co.
- b. Appleton Electric Co.
- c. Adalet-PLM
- d. Or equal.

## 2.4 MISCELLANEOUS FITTINGS

### A. Flexible Couplings:

#### 1. Manufacturers: Provide products by one of the following:

- a. "Type ECGJH," by the Crouse-Hinds Co.
- b. Appleton Electric Co.
- c. Killark Electric Manufacturing Co.
- d. Or equal.

### B. Conduit Hubs:

#### 1. Manufacturers: Provide products by one of the following:

- a. Myers Electric Products, Inc.
- b. Or equal.

### C. Conduit Wall Seals For Cored Holes:

#### 1. Products: Provide one of the following:

- a. Type CSMC as manufactured by the O.Z./Gedney Co.
- b. Or equal.

### D. Conduit Wall And Floor Seals For Sleeved Openings:

#### 1. Products: Provide one of the following:

- a. Type CSMI as manufactured by the O.Z./Gedney Co.
- b. Or equal.

### E. Combination Expansion-Deflection Fittings Embedded In Concrete:

#### 1. Products: Provide one of the following:

- a. Type XD as manufactured by the Crouse-Hinds Co.
- b. Type DX as manufactured by O.Z./Gedney Co.
- c. Type DF as manufactured by Appleton Electric Co.
- d. Or equal.

### F. Combination Expansion-Deflection Fittings Installed Exposed:

#### 1. Products: Provide one of the following:

- a. Type XD as manufactured by Crouse-Hinds Co.

- b. Type DX as manufactured by O.Z. Gedney Co.
- c. Type DF as manufactured by Appleton Electric Co.
- d. Or equal.

G. Explosion Proof Fittings:

1. Manufacturers: Provide products by one of the following:

- a. Crouse-Hinds Co.
- b. Appleton Electric Co.
- c. O.Z./Gedney Co.
- d. Or equal.

H. Conduit Sealing Bushings:

1. Products: Provide one of the following:

- a. O.Z./Gedney, Type CSB.
- b. Or equal.

I. Grounding Bushings: Malleable iron with integral insulated throat rated for 300 degrees F, with solderless lugs.

1. Products: Provide one of the following:

- a. Crouse Hinds/Cooper, Series HGLL.
- b. Appleton, Series GIB.
- c. O.Z./Gedney, Type HBLG.
- d. Or equal.

## 2.5 HARDWARE

A. Conduit Mounting Equipment:

- 1. In dry indoor areas, provide hangers, rods, backplates, beam clamps, channel, etc. fabricated from galvanized iron or steel.
- 2. In areas indicated "WET" or "CORROSIVE" on the Drawings and in outdoor locations use PVC coated steel channel with stainless steel hardware. Provide fiberglass channel resistant to the chemicals present in the area in which it is used.

B. Furnish all supports, brackets, conduit sleeves, racks and bracing required. Provide boxes and hardware fabricated from galvanized zinc plated steel, except provide stainless steel in areas indicated as "WET", "CORROSIVE", Class I Division 1, Class I Division 2, or outdoors on the Drawings.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

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

1. Crouse-Hinds, an Eaton business.
  2. Electromate Division of Robroy Ind.
  3. Hoffman.
  4. RACO; Hubbell.
  5. Steel City.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- E. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- H. Gangable boxes are prohibited.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  2. Hinged door in front cover with flush latch and concealed hinge.
  3. Key latch to match panelboards.
  4. Metal barriers to separate wiring of different systems and voltage.
  5. Accessory feet where required for freestanding equipment.
  6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- K. Locations for Enclosure Types:
1. Use NEMA 4X Type 316 stainless steel enclosures in the following locations:
    - a. Outdoors
    - b. Areas indicated as "WET" or "DAMP" on the Drawings.
    - c. Areas indicated as "CORROSIVE" on the Drawings.

2. NEMA 7 enclosures will be used in the following locations:
  - a. Areas indicated as Class I, Division 1 or Class I, Division 2.

### PART 3 - EXECUTION

#### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  1. Exposed Conduit: PVC-coated GRC.
  2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  3. Boxes and Enclosures, Aboveground: NEMA 250, Type 4x.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
  1. Exposed, Not Subject to Physical Damage (clean and dry administrative areas, such as offices): GRC.
  2. Exposed, Not Subject to Severe Physical Damage (clean and dry equipment rooms, such as electrical room or mechanical room): GRC.
  3. Exposed and Subject to Severe Physical Damage (process areas): PVC-coated GRC. Raceway locations include the following:
    - a. Screen Room.
  4. Concealed in Ceilings and Interior Walls and Partitions: GRC in equipment rooms, and PVC-coated GRC in process areas.
  5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC in damp or wet locations.
  6. Damp or Wet Locations: GRC.
  7. Boxes and Enclosures: NEMA 250, Type 12, except use NEMA 250, Type 4x 316 stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
  1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Internally and Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use compression fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

### 3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- H. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- I. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- J. Support conduit within 12 inches of enclosures to which attached.
  - 1. In concrete unless specifically approved by Engineer for each specific location.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

- P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- S. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Conduit extending from interior to exterior of building.
  - 4. Conduit extending into pressurized duct and equipment.
  - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6. Where otherwise required by NFPA 70.
- T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- U. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit forequipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- W. Mount boxes at heights indicated on Drawings. Install boxes with height measured to bottom of box unless otherwise indicated.
- X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Y. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- Z. Locate boxes so that cover or plate will not span different building finishes.
- AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- CC. Set metal floor boxes level and flush with finished floor surface.
- DD. In hazardous locations, seal conduits terminating at boxes enclosing circuit opening equipment at the entrance to the enclosure with approved compound filled sealing fittings to prevent passage of explosive or combustible gases through the conduits. Similarly seal all conduits leading from or entering hazardous locations at points of exit or entrance. Seal exposed conduits passing through hazardous locations at both the entrance to and the exit from the hazardous locations. A sealing compound installation schedule shall be presented to the Engineer for approval. Sign off on each installation and present the compound installation schedule to the Engineer for final sign-off. Each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.
- EE. Install conduit sealing and drain fittings in all hazardous (classified) areas designated Class 1, Division 1, and Class 1, Division 2.
- FF. Install conduit sealing and drain fittings on all conduits entering and leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are: rooms where chlorine, ammonia, and ozone are stored, generated or heated. A sealing compound installation schedule shall be presented to Engineer for approval. Sign off on each installation and present the compound installation schedule to the Engineer for final sign-off. Each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.
- GG. Use liquid-tight flexible metal conduit for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal. The length of liquid-tight flexible metal conduit shall not exceed 36



inches when used for vibration isolation and shall not exceed 72 length when attaching to luminaires. Non-metallic flexible conduit shall only be allowed for use with rigid PVC conduit systems.

- HH. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

### 3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533



## SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 SLEEVES

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
  - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
  - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
  - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Products & Systems, Inc.
  - b. CALPICO, Inc.
  - c. Metraflex Company (The).
  - d. Pipeline Seal and Insulator, Inc.
  - e. Proco Products, Inc.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. HOLDRITE.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- C. Sample of metal tags.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70.
- B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- C. Comply with ANSI Z535.4 for safety signs and labels.

- D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Color-Coding for Identification, 600 V or Less: Use colors listed below for conductors.
  - 1. Color shall be factory applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
    - d. Neutral: White.
  - 3. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
    - d. Neutral: White.
  - 4. Color for Equipment Grounds: Green.
  - 5. Colors for Isolated Grounds: Green with white stripe.
- B. Raceways and Cables Carrying Circuits at More Than 600 V:
  - 1. Black letters on an orange field.
  - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- C. Warning labels and signs shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- D. Equipment Identification and Source Nameplates:
  - 1. White nameplate with black letters.
  - 2. Nameplates shall be engraved, laminated plastic, not less than 1/16-inch thick by ¾-inch by 2-1/2-inch with 3/16-inch high lettering.
  - 3. All electrical equipment furnished under Divisions 26, 27, 28 and all equipment control panels furnished under other Divisions shall include equipment identification nameplates. Equipment includes motor control centers, disconnect switches, separately mounted



motor controllers, control panels, named terminal cabinets, etc. The designation of the equipment shall correspond to the designation shown on the Drawings.

4. Equipment identified in the previous paragraph above shall also include a nameplate with the power source identified

E. Device Identification Labels:

1. White nameplate with black letters.
2. Labels shall be self-adhesive type and machine generated with 1/4-inch high letters.
3. All receptacles, wall switches, lighting fixtures, photo cells, emergency lights, exit lights, instruments, etc. shall be identified with the panel and circuit to which it is connected.

## 2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Champion America.
  - c. Panduit Corp.

## 2.4 BANDS AND TUBES

A. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Panduit Corp.

## 2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Champion America.
  - b. Ideal Industries, Inc.
  - c. Panduit Corp.

- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. Marking Services, Inc.
- C. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Seton Identification Products.

## 2.6 TAGS

- A. Metal Tags: Brass or stainless steel, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. Marking Services, Inc.

## 2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
- C. Exposed conduit and cable labels shall indicate system voltage, type of service (i.e., Control Circuits, Power, Lights), origin, and termination. Refer to “Identify Raceways and Exposed Cables of Certain Systems with Color Banding” Paragraph in Article “Identification Schedule” for exposed conduit and cable identification band requirements.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### 3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Clean surfaces of dust, loose material, and oily films before applying.
- E. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, operation and maintenance manual, and the Owner.
- F. Apply identification devices to surfaces that require finish after completing finish work.
- G. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- H. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."

4. "CONTROL."
  5. "SIGNAL."
- L. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- M. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- O. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- P. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- Q. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- R. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- S. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- T. Metal Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using stainless steel wire or chain.
- U. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- V. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

W. Equipment Nameplates:

1. Nameplates shall be screw mounted to NEMA 1 enclosures.
2. Nameplates shall be bonded to all other enclosure types using an epoxy or similar waterproof adhesive.

### 3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Identify Raceways and Exposed Cables of Certain Systems with Color Banding: Band exposed and accessible raceways of systems listed below for identification.
1. Bands: Pre-tensioned, snap around, colored plastic sleeves; colored adhesive tape; or combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of 2 color markings in contact, side by side.
  2. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot in congested areas.
  3. Colors: As follows:
    - a. Fire Alarm System: Red.
    - b. Fire Suppression Supervisory and Control System: Red and yellow.
    - c. Combined Fire Alarm and Security System: Red and blue.
    - d. Security System: Blue and yellow.
    - e. Mechanical and Electrical Supervisory System: Green and blue.
    - f. Telecommunications System: Green and yellow.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
  2. "POWER."
  3. "UPS."
  4. "CONTROL."
  5. "SIGNAL."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- J. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- K. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
  1. Apply to exterior of door, cover, or other access.
  2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - a. Power-transfer switches.
    - b. Controls with external control power connections.
- M. Operating Instruction Signs: Self-adhesive labels.
- N. Equipment Identification Labels:
  1. Indoor Equipment: Self-adhesive label.
  2. Outdoor Equipment: Laminated acrylic or melamine sign.
  3. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Motor-control centers.

- e. Enclosed switches.
- f. Enclosed circuit breakers.
- g. Enclosed controllers.
- h. Variable-speed controllers.
- i. Push-button stations.
- j. Power-transfer equipment.
- k. Contactors.
- l. Remote-controlled switches, dimmer modules, and control devices.

O. Junction and Pull Box Nameplates:

- 1. All voltages (e.g. 480 volts, 120 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Provide Signs with red background with white engraved lettering. Provide lettering a minimum of 1 inch high.

P. Panelboard Identification

- 1. Label branch circuit wires with associated pole number using vinyl cloth wrap around labels.
- 2. Provide typed as built circuit directories giving location and nature of load served. Install circuit directories in each panelboard.
- 3. Provide each panelboard with two nameplates. The first shall be provided by the panelboard manufacturer and shall identify the panel. The second shall be field installed by the Contractor to identify the panel's upstream power source.

END OF SECTION 260553





## SECTION 262416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. UPS Panelboards.

#### 1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details.
  - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

## 1.7 FIELD CONDITIONS

- A. Environmental Limitations:
  1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
  2. Do not proceed with interruption of electric service without Owner's written permission.
  3. Comply with NFPA 70E.

## 1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
  1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PANELBOARDS COMMON REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.
- D. Enclosures: Surface-mounted, dead-front cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Height: 84 inches maximum.
  - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
  - 4. Finishes:
    - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Same finish as panels and trim.
- E. Incoming Mains:
  - 1. Location: Top.
  - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- F. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
    - a. Plating shall run entire length of bus.
    - b. Bus shall be fully rated the entire length.
  - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
  - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
  - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  - 4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
  - 5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.

6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
  1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## 2.2 UPS PANELBOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Siemens Industry, Inc., Energy Management Division.
  3. Square D; Schneider Electric USA.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Siemens Industry, Inc., Energy Management Division.
  3. Square D; Schneider Electric USA.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
  1. Thermal-Magnetic Circuit Breakers:
    - a. Inverse time-current element for low-level overloads.
    - b. Instantaneous magnetic trip element for short circuits.
    - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
  3. MCCB Features and Accessories:

- a. Standard frame sizes, trip ratings, and number of poles.
- b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.

## 2.4 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
  1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:

1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- F. Mount panelboard cabinet plumb and rigid without distortion of box.
- G. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- H. Install overcurrent protective devices and controllers not already factory installed.
  1. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- I. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- J. Install filler plates in unused spaces.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:

1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262416





## SECTION 262419 - MOTOR CONTROL CENTERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes modifications to the existing MCC as shown on the Drawings and as specified herein.

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCC: Motor-control center.
- C. MCCB: Molded-case circuit breaker.
- D. MCP: Motor-circuit protector.
- E. OCPD: Overcurrent protective device.
- F. PID: Control action; proportional plus integral plus derivative.
- G. PT: Potential transformer.
- H. SPD: Surge protective device.
- I. SCR: Silicon-controlled rectifier.
- J. VFC: Variable-frequency controller.
- K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Submit shop drawings and product data of the follows:

1. Product data sheets and catalog numbers for overcurrent protective devices, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this Project.
2. Provide individual bucket elementary drawings showing internal wiring and interlocking with remotely mounted devices. Show wire and terminal number.
3. Show tabulations of installed devices, equipment features, and ratings. Include the following:
  - a. Each installed unit's type and details.
  - b. Enclosure types and details.
  - c. Nameplate legends.
  - d. Short-circuit current (withstand) rating of components.
  - e. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
  - f. Specified optional features and accessories.
  - g. MCC bucket door layout including all components, such as switches, buttons, nameplate, etc.
4. Schematic Wiring Diagrams: For power, signal, and control wiring for each installed controller.
5. Nameplate legends.
6. Layout of MCC bucket doors including, but not limited to, switches, pilot lights, external handle, and identification nameplate.

## 1.5 QUALITY ASSURANCE

- A. The new circuit breakers, fused switches and motor starters will be the product of the original manufacturer of the motor control center in which they are being installed.
- B. Modifications shall maintain UL listing of the equipment.
- C. Modifications will be made by a Contractor specializing in this type of work. Submit qualifications and experience on past similar projects for approval.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Furnish new or replacement starter units complete with new circuit breakers, control transformers, and overload relays. Do not re-use existing parts used unless noted otherwise.
- B. Rewire the control circuits to provide the control schemes shown on the Drawings.

## 2.2 RATING

### A. Rating

1. Component short circuit ratings will be not be less than minimum rated device in the motor control center. Maintain the overall short circuit rating of the existing motor control center. Components will be rated 600 volts.
  2. Maintain the integrity of series rated devices. Series combinations will be UL listed.
- B. Test and UL label motor starter units for the specified short circuit duty in combination with the motor branch circuit protective device.
- C. Design new devices installed in existing motor control centers for continuous operation at rated current in a 40 degree C ambient temperature. Follow the manufacturer's recommended clearances and ventilation practices to prevent overheating and to maintain UL listing.

## 2.3 CONSTRUCTION

### A. Enclosure

1. Provide new sheet metal cubicles and doors to match existing equipment enclosure as required. New cubicles will be supplied by the original equipment manufacturer where possible. Where existing units are obsolete, new cubicles may be supplied by a third-party vendor.
2. Provide individual, flange formed, pan type door with concealed hinges and quarter turn latches for each device compartment as required. Doors will be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.

### B. Unit Compartments

1. Provide individual compartments for each removable combination starter and feeder tap device unit. Steel barriers shall isolate the top, bottom and sides of each compartment from adjacent units and wireways. Removable units shall connect to the vertical bus in each section with tin plated, self-aligning, pressure type copper plug connectors. Size 5 and larger starter units may be wired directly to the bus. Removable units will be aligned in the structure on guide rails or shelves and secured with a cam latch mechanism or racking screw.
2. Provide individual, isolated compartments for fixed mounted devices such as circuit breakers, cable lugs, metering, relaying and control devices. Directly wire main and bus tie circuit breakers directly to the main horizontal bus. All bus connections will be fully rated.
3. Provide the following features:
  - a. Provision to padlock removable units in a partially withdrawn TEST position, with the bus stabs disengaged.
  - b. Provision to padlock unit disconnect handles in the OFF position with up to three padlocks.
  - c. Mechanical interlock with bypass to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.

- d. Mechanical split-type terminal blocks for disconnecting external control wiring.
- e. Auxiliary contact on unit disconnect to isolate control power when fed from an external source.
- f. Disconnect operating handles and control devices mounted on the removable units.
- g. Compartments containing motor starters shall have wiring diagrams and heater tables fastened to the compartment door. Compartments containing panelboards shall have circuit directories fastened to the compartment door.

C. Wiring

1. Wiring: Stranded copper, minimum size No. 14 AWG, with 600 Volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring will be sized for the full rating or frame size of the connected device.
2. Identification: Numbered sleeve type wire markers at each termination point, color coding per NEMA Standards and the NEC.

D. Nameplates

1. Provide 1-in by 3-in engraved nameplates for new units of two-ply laminated plastic, black face, white core, screw fastened to each door with stainless steel screws. Equipment names are as shown on the single line diagrams.

## 2.4 COMPONENTS

A. General

1. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the NEMA size starter, circuit breaker trip ratings, control power transformers and thermal overload heater element ratings matched to the motors and control equipment actually supplied, in compliance with the National Electrical Code and the manufacturer's heater selection tables. All variations necessary to accommodate the motors and controls as actually furnished will be made at no additional cost to the Owner.

B. Branch Circuit Feeder Breakers (Non-motor loads)

1. Molded case circuit breakers: Thermal-magnetic trip type, 600 volt, 2 or 3 pole as required, labeled in accordance with UL Standard 489. Circuit breakers will be fully rated to meet the specified equipment short circuit rating. Provide independently adjustable magnetic trips on 225A frame breakers and larger.

C. Fusible Switches

1. Fused switches: Heavy duty, quick make, quick break, 3 pole, 600 volt with visible break contacts, equipped with Class R fuse clips and current limiting fuses.

D. Combination Starter Units

1. Combination starters shall include a motor circuit protector (MCP) in series with a motor controller and an overload protective device. The MCP shall have an adjustable magnetic

trip range up to 1000 percent of rated continuous current and a trip test feature. MCPs will be labeled in accordance with UL489.

2. Motor starters: 3 pole, 600 volt, electrically operated, of the types shown on the Drawings. Provide NEMA sizes as required for the horsepower shown on the Drawings. Minimum size will be NEMA Size 1. Fractional size starters are not acceptable. IEC rated starters shall have continuous current ratings equal to or greater than the continuous current ratings listed in Table 2-321-1 of NEMA Standard Publication ICS 2-1978. Starters shall have 120 volt encapsulated operating coils; individual control power transformers with primary and secondary fuses and silver cadmium oxide renewable line contacts.
3. Contactors: Electrically held, 120 VAC coil operator, suitable for tungsten, ballast, or resistive non-motor loads, with over current protection, control transformer and contact ratings and poles as shown on the Drawings.
4. Motor overload protection: Ambient compensated, adjustable, 3 pole, thermal bi-metallic type, with push-to-test feature. Overload relays will be manually reset from outside the enclosure by means of an insulated pushbutton. Provide auxiliary alarm contacts where shown on the Drawings.
5. Auxiliary contacts: Form C, NEMA A600 rating, as required by the control schemes on the Drawings. Provide 1-normally open and 1-normally closed spare contacts on each starter. Furnish additional auxiliary contacts as shown on the Drawings or as required by the control schematic and this Section.
6. Control power transformers: Two winding type, 120 VAC secondary, fused in accordance with the NEC. Provide extra capacity as required or where shown on the Drawings.

E. Relays and Timers

1. Control relays and timers: IEC industrial type with 10 Ampere, 600 Volt, fixed contacts, modular design, DIN rail mounted, Square D Type PH; Cutler Hammer/Westinghouse Type DSL9 or equal. Provide transient suppressors on coils and pneumatic timing or latching attachments as required by the control schemes on the Drawings.

F. Pilot Devices

1. Control operators: Heavy duty, full size, oiltight, with NEMA A600 contact rating. Types and quantities as shown on the Drawings.
2. Indicator lights: Full size, oil-tight, low voltage, with push-to-test feature. Colors and quantities as shown on the Drawings.

## 2.5 SURFACE PREPARATION AND SHOP COATINGS

- A. Clean new metal parts of the control center assembly of all weld spatter and other foreign material and given a phosphatized chemical pre-treatment and two coats of primer to inhibit rust.
- B. New equipment will be finish painted with one coat of polyurethane enamel to match existing color.
- C. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion.

## 2.6 MAGNETIC CONTROLLERS

- A. Controller Units: Combination controllers.
- B. Disconnects:
  - 1. MCP:
    - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
- C. Controllers: Comply with UL 508.
  - 1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.
    - a. Classification: Nonreversing and reversing.
- D. Overload Relays:
  - 1. Solid-State Overload Relays:
    - a. Switch or dial selectable for motor-running overload protection.
    - b. Sensors in each phase.
    - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - e. Analog communication module.
  - 2. NC and NO isolated overload alarm contact.
  - 3. External overload reset push button.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. In accordance with manufacturer's instructions and recommendations, modify the existing motor control center. Provide all hardware necessary for installation.
- B. Neatly group by circuit and bound by plastic tie wraps field installed interior wiring. Support circuit groups so that circuit terminations are not stressed.
- C. Touch-up damaged paint finishes.
- D. Make wiring interconnections between units.

- E. Make two-hole NEMA lugs for cable connections to existing bus. Remove busbar sections for shop drilling and re-install. Re-torque all connections. Fabricate and install any custom bus extensions

### 3.2 FIELD TESTING

- A. Make the following minimum tests and checks before energizing modified equipment.
  - 1. Megger buses, phase-to-phase and phase-to-ground after disconnecting devices sensitive to megger voltage.
  - 2. Install overload heaters or adjust relays for actual motor nameplate currents. If capacitors are installed between starter and motor, use overload relay heaters based on measured motor current.
  - 3. Check mechanical interlocks for proper operation.
  - 4. Test ground connections for continuity and resistance.
  - 5. Adjust unit compartment doors.
  - 6. Check control circuit interlocking and continuity with starters in the TEST position. Provide external source of control power for this test.
  - 7. Adjust motor circuit protectors and voltage trip devices to their correct settings.
- B. In the event of an equipment fault, notify the Owner immediately. After the cause of the fault has been identified and corrected, conduct a joint inspection of the equipment with the Engineer and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

### 3.3 ADJUSTMENT

- A. Test all operational features of the installed equipment to the satisfaction of the Owner. Submit a certified copy of the field inspection to the Engineer. No equipment will be energized without the approval of the Engineer.
- B. Make the following inspection, tests and adjustments:
  - 1. Inspect the installation for compliance with the manufacturers recommended installation practices and report all deviations to the Engineer.

### 3.4 CLEANING

- A. Remove all rubbish and debris from inside and around the control center. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION 262419





## SECTION 262505 – 480V CONTROL PANELS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes industrial control panels with the following features:
  - 1. Enclosure.
  - 2. Main circuit breaker.
  - 3. Motor controllers.
  - 4. Control and monitoring devices.
  - 5. Accessories.
  - 6. Identification.
- B. Related Requirements:
  - 1. Division 26 for electrical work
  - 2. Division 40 for process automation requirements

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer
- B. GFCI: Ground-fault circuit interrupter
- C. MCCB: Molded-case circuit breaker
- D. MCP: Motor circuit protector
- E. NEC: National Electrical Code
- F. RVSS: Reduced voltage soft start
- G. RVAT: Reduced voltage autotransformer start
- H. SCCR: Short-circuit current rating
- I. SPD: Surge protective device
- J. UL: Underwriter's Laboratories

- K. VFC: Variable frequency motor controller. See VFD
- L. VFD: Variable frequency drive. Used interchangeably with the term VFC.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each control panel.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each control panel.
  - 1. Include dimensioned plans, elevations, sections, and details.
  - 2. Bill of materials with part numbers, cross-referenced to plans.
  - 3. Nameplate schedule.
  - 4. Conduit entrance locations and mounting details.
  - 5. Power and control schematics.
  - 6. Certification for compliance with UL 508A.
  - 7. Identification per NEC 409.110.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Startup reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following if applicable:
  - 1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
  - 2. Manufacturer's written instructions for setting field-adjustable overload relays.
  - 3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
  - 4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
  - 5. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
  - 6. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Control fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than two of each size and type.
  - 2. Power fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than three of each size and type.
  - 3. Corrosion Inhibitor: Equal to 100 percent of total number of control panels. (One spare per panel.)

## 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store control panels indoors in clean, dry space with uniform temperature to prevent condensation. Protect control panels from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## 1.10 SPARE PARTS

- A. Provide the following spare parts for each control panel in the quantities specified:
  - 1. One dozen replacement fuses, all types and sizes
  - 2. Two dozen replacement lamps for pilot lights
  - 3. One dozen of each color replacement lens caps for pilot lights
  - 4. One starter coil for each NEMA size furnished
  - 5. One, 3-pole set of replacement overload heaters of each size range used
  - 6. One, 3-pole set of starter contacts of each NEMA size used
  - 7. One can of aerosol touch-up paint
- B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturer's name, description and part number on the exterior of the package.

## 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace control panels that fail in materials or workmanship within specified warranty period.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
  - 1. SPD Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for control panels clearances between control panels and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. Comply with NEMA ICS 6: Industrial Control and Systems: Enclosures.
- E. Comply with UL 1203 for control panels located in hazardous (classified) locations.
- F. Comply with NFPA 70.
- G. Comply with UL 508A.
- H. Complete and fully functional control to manually or automatically operate the control system as specified herein and in other applicable sections of these specifications. Include manufacturer's recommended safety devices to protect operators. All control devices, unless specified otherwise, mounted in the Control Panel.
- I. The control panel shall operate on a power supply of 480 volts, 3-phase, 60 hertz unless otherwise noted.
- J. Control panel consists of a main circuit breaker, motor circuit protector (MCP) and motor controller for each motor, and a 120-volt control power transformer (fused on primary and secondary) along with other devices specified. Mount all control components in one common enclosure.
- K. Operation of motors will be manually or automatically. Stager control of multiple motors to prevent simultaneous motor starting.
- L. All electronic control equipment (i.e. controllers, isolators, signal boosters, transmitters, PLC's, etc.) shall be as specified in Division 40.
- M. SCCR: Control panels with main breakers of 125 amps or less shall have SCCR of 65kA, unless specifically noted elsewhere.

### 2.2 ENCLOSURES

- A. Enclosures: Surface-mounted, dead-front cabinets rated for environmental conditions at installed location. Unless noted elsewhere, NEMA rating shall be NEMA 12, minimum 14 gauge. All exterior mounted equipment shall be NEMA 4X.
- B. Construction: The door shall be mounted via continuous hinged and provided with a pad-lockable vault type 3-point latch. The enclosure shall be equipped with a door and shall incorporate a

removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Door(s) shall be interlocked with main circuit breaker and provided with pad-locking provision.

- C. All motor branch circuit breakers, motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.
- D. Operating handle for main circuit breaker: Provide an external flange-mounted, knife-blade main power disconnect switch operating handle with mechanical interlock having a bypass that will allow the control panel door to open only when the switch is in the OFF position.
- E. Provide additional temperature control if required to meet UL temperature rating of internal components. If forced air ventilation is required, the enclosure shall be pressurized. Air filters shall be of commercially available types and sizes.
- F. All operating control and instruments shall be securely mounted on the exterior door. All controls and instruments shall be clearly labeled to indicate function. All exterior mounted equipment shall be NEMA 4X.
- G. Print storage pockets shall be provided on the inside of each panel. Pocket shall be of sufficient size as required to hold all prints necessary to service the equipment.
- H. Where the project has multiple control panels, suggest including a table of SCCR requirements for the paragraph below – design engineer to perform short circuit calculations to confirm.

## 2.3 COMPONENTS

- A. Main Breaker: Thermal-magnetic air circuit breaker, Schneider Electric/Square D PowerPact Type BG (125 amp frame, 35kAIC) or equal.
- B. MCP: Molded case motor circuit protector with adjustable magnetic trip only, Schneider Electric/Square D “Mag-Gard” or equal.
- C. Motor Controller:
  - 1. Full Voltage Motor Starting: Open frame, across-the-line, NEMA-rated magnetic motor starter, Schneider Electric/Square D Class 8536 or equal. Solid state overloads with Class 10/20 selectable tripping. Submersible motors shall use Class 10 trip curve.
  - 2. Reduced voltage motor starting: VFD as specified in Section 262923 “Variable-Frequency Motor Controllers”.
- D. Overload relays shall be self-powered solid-state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test.
- E. Overload reset buttons shall be mounted on dead front door.

- F. Normally open and normally closed auxiliary motor overload contacts wired to terminal blocks shall be provided for each motor starter within the control panel.
- G. SPD: The control panel shall be provided with a surge protective device (SPD) rated for 100kA per mode for the incoming power. SPD shall be mounted within the control panel enclosure. Lead lengths shall not be longer than 12 inches from the main circuit breaker.
- H. Control Power Transformer: 480-120V CPT, fused on primary and secondary sides, capacity as required.

## 2.4 CONTROL DEVICES AND ACCESSORIES

- A. Control Operators and Indicators:
  - 1. Heavy duty type, full size (30.5mm), NEMA 12 or 7 as required.
  - 2. Each motor shall include Hand-Off-Auto selector switches to permit override of automatic control and manual actuation of shutdown.
- B. Indicating Lights:
  - 1. LED, full size (30.5mm), full voltage and push-to-test type.
  - 2. Indicators shall be provided for individual motor run and an indicator for each failure condition.
- C. Relays:
  - 1. Control relays shall be 10 amp rated contacts (minimum), 11 pin with mounting base, 3PDT (minimum), with LED indicators to show relay status, relays shall be manufactured by Square D, IDEC RR Series, or Allen Bradley 700-CF. No substitutions permitted.
  - 2. Timing relays shall be solid state, with pin (octal) and bases, relays shall be manufactured by Square D, IDEC GT3A, or Allen Bradley 700-HT. No substitutions permitted.
  - 3. Intrinsically safe relays shall be solid state type with 5 amp output contacts, suitable for use on 120 volt, 60 hertz power supply and shall be Factory Mutual approved for devices in Class 1, Division 1 hazardous atmospheres. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or equal.
- D. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by Divisions 40, 26 and as shown on the Drawings.
- E. Alternators shall be provided to sequence lead/lag motors, alternators shall be 008-120-13SP or 009-120-23AP as manufactured by Sta-con, or equal.
- F. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter, selected by the manufacturer, to protect internal components of control panel from corrosion for up to one year.

## 2.5 WIRING

- A. Power and control wire shall be 600 Volt class, Type THHN/THWN insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover.
- B. Wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600 Volt, 90 degree C, flame retardant, Type THHN/THWN thermoplastic insulation.
- C. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks.
- D. Terminal blocks shall be 600 Volt heavy duty rated, tubular clamp type. Terminal strips shall be Allen Bradley catalog #1492-J4, Weidmuller W Series, or equal.
- E. A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.
- F. All signal wiring entering and exiting the control panel shall be provided with surge protection. Surge protection shall be as specified in Division 40.
- G. An 8-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A 4-inch (minimum) clear space within the enclosure shall be provided vertically along the entire sides of the control panel. No devices, terminals, etc. shall be installed within this space, the space shall be provided for field conduit and wiring access only.

## 2.6 IDENTIFICATION

- A. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.
- B. The control diagrams and overload tables shall be laminated to the inside of the door except where door space is limited the laminated documents shall be in the print storage pocket.
- C. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process (inner door nameplates shall be fastened with stainless steel screws). Nameplates shall be laminated plastic, engraved black letters with a white background.
- D. All control panels shall be provided with two nameplates located on the exterior door. The first nameplate shall identify the control panel name. The second nameplate shall identify the power source.
- E. Where applicable provide a nameplate which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Letters shall be black on a high visibility yellow background.
- F. Each terminal at terminal blocks shall be individually labeled.

- G. Incoming phase conductor terminals shall be clearly identified. All wiring within the control panel shall be color coded or coded using electrical tape in sizes where colored insulation is not available. The following coding shall be used.

<b>System</b>	<b>Wire</b>	<b>Color</b>
Incoming line voltage	Phase conductors	Brown/Orange/Yellow
	Ground	Green
	Neutral (as required)	Gray
Internal control voltage	AC	Red
	Neutral	White
Internal control voltage	DC	Blue
	Neutral	White
External source	All	Yellow

## 2.7 FACTORY TESTS

- A. Inspect and test control panel for correct operation. Test each circuit for continuity, short circuits, and ground faults.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Inspect anchorage, alignment, grounding, and clearances.
- C. Compare equipment nameplate data for compliance with Drawings and Specifications.
- D. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- E. Motor Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.
- F. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."



### 3.2 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Verify motor running protection is appropriate for actual motors installed.
- C. Test control panel with all field wiring connected. Set adjustable set points and time delays for proper operation of equipment. Adjust as required.
- D. Perform infrared inspection of panel interior during periods of maximum possible loading. Remove all necessary covers prior to the inspection. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
- E. Prepare test and inspection reports.
- F. Install a set of legible "as built" control panel drawings (11x17 or 8.5 x 11), in the storage pocket.

### 3.3 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain equipment.

END OF SECTION 262505



## SECTION 262716 - ELECTRICAL CABINETS AND ENCLOSURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Hinged cover enclosures.
2. Cabinets.
3. Terminal blocks.
4. Accessories.

- B. Related Requirements:

1. Section 260526 "Grounding and Bonding for Electrical Systems."
2. Section 260529 "Hangers and Supports for Electrical Systems."
3. Section 260533 "Raceway and Boxes for Electrical Systems."

#### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's standard data for enclosures, cabinets, and terminal blocks.
- B. Manufacturer's Instructions: Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Qualification Statements:
  1. Submit manufacturer, and fabricator, experience qualifications, including proof manufacturer is UL-certified for fabricating control panels (UL-508A).
  2. Submit manufacturer's approval of fabricator.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials:

1. Furnish two of each key.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

## PART 2 - PRODUCTS

### 2.1 HINGED COVER ENCLOSURES

- A. Manufacturers:
1. Hoffman
  2. Hammond
  3. Wiegmann; Hubbell Inc.
  4. No substitutions permitted.
- B. Description: NEMA 250, Type 12 steel enclosure; Type 4X fiberglass reinforced plaster with stainless steel hardware and gasketed covers; Type 7 designed for Class 1, Group D, Division 2 hazardous locations and cast iron with cadmium-zinc or hot-dipped galvanized finish, stainless steel or hot-dipped galvanized bolts.
1. Covers: Continuous hinge, held closed by flush latch operable by screwdriver.
  2. Furnish interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.
  3. Enclosure Finish: Manufacturer's standard enamel.

### 2.2 CABINETS

- A. Manufacturers:
1. Hoffmman
  2. Hammond
  3. Rittal
  4. No substitutions permitted.
- B. Description:
1. Boxes: Galvanized steel with removable end walls.
  2. Box Size: 24 inches wide x 24 inches high x 6 inches deep, or as required.
  3. Backboard: Furnish metal panel for mounting terminal blocks. Paint matte white.
  4. Fronts: Steel, surface type with screw cover front, door with continuous hinge, and flush lock keyed to match branch circuit panelboard.
- C. Fabrication
1. Furnish metal barriers to form separate compartments wiring of different systems and voltages.
  2. Furnish accessory feet for free-standing equipment.

D. Finishes:

1. Finish with gray baked enamel.

2.3 TERMINAL BLOCKS

A. Manufacturers:

1. Allen-Bradley 1492-J4
2. Weidmuller W Series
3. Square D
4. No substitutions permitted.

B. Description:

1. Terminal Blocks: NEMA ICS 4.
2. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
3. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
4. Furnish ground bus terminal block, with each connector bonded to enclosure.

2.4 PLASTIC RACEWAY

A. Manufacturers:

1. Panduit Corp
2. IBOCO
3. Wiremold / Legrand
4. No substitutions permitted.

B. Description: Plastic channel with snap-on cover.

2.5 CORROSION PROTECTION

A. Manufacturers; Emitter:

1. Cortec Corporation
2. Or approved equal.
3. Description: Foam emitter to provide long term protection against corrosion by airborne contaminants.
  - a. For each enclosure, furnish quantity as indicated in manufacturer's instructions to protect the enclosure.

B. Manufacturers; Absorber:

1. Cortec Corporation
2. Or approved equal.

3. Description: Plastic cup with breathable membrane to absorb corrosive gasses from the enclosure.
  - a. For each enclosure, furnish quantity as indicated in manufacturer's instructions to protect the enclosure.

### PART 3 - EXECUTION

#### 3.1 DEMOLITION

- A. Remove abandoned cabinets and enclosures, including abandoned cabinets and enclosures above accessible ceiling finishes. Patch surfaces.
- B. Maintain access to existing cabinets and enclosures and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Extend existing cabinets and enclosures using materials and methods compatible with existing electrical installations, or as specified.

#### 3.2 REPAIR

- A. Repair existing cabinets and enclosures to remain or to be reinstalled.

#### 3.3 INSTALLATION

- A. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner in accordance with Section 260529.
- B. Install cabinet fronts plumb.

#### 3.4 CLEANING

- A. Clean existing cabinets and enclosures to remain or to be reinstalled.
- B. Clean electrical parts to remove conductive and harmful materials.
- C. Remove dirt and debris from enclosure.
- D. Clean finishes and touch up damage.

END OF SECTION 262716

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Nonfusible switches.

### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include wiring diagrams for power, signal, and control wiring.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
  - 1.

- B. Field quality-control reports.

## 1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL or a NRTL if approved by the Owner and/or Engineer, and marked for intended location and application.
- D. Comply with NFPA 70.

### 2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Products Division.
  - 2. Eaton.
  - 3. Siemens Industry, Inc., Energy Management Division.
  - 4. Square D; Schneider Electric USA.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.



4. Lugs: Mechanical type, suitable for number, size, and conductor material.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

### 3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
  2. Indicate method of providing temporary electric service.
  3. Do not proceed with interruption of electric service without Owner's written permission.
  4. Comply with NFPA 70E.

### 3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 4X.
  3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.
  4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  5. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

### 3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- C. Comply with NFPA 70 and NECA 1.

### 3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections for Switches:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
    - i. Verify correct phase barrier installation.
    - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
  - 2. Electrical Tests:
    - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar

- connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- 3.
- B. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
  - C. Prepare test and inspection reports.
    1. Test procedures used.
    2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
    3. List deficiencies detected, remedial action taken, and observations after remedial action.
- 3.7 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816



## SECTION 262913.03 - MANUAL AND MAGNETIC 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. Section Includes:
  - 1. Combination full-voltage magnetic motor controllers.
  - 2. Combination multispeed magnetic motor controllers.
  - 3. Accessories.
  - 4. Identification.

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of magnetic controller.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.

3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
  - a. Listing document proving Type 2 coordination.
7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.
  1. Routine maintenance requirements for magnetic controllers and installed components.
  2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  3. Manufacturer's written instructions for setting field-adjustable overload relays.
  4. Projects with multiple sizes and types of controllers might include different types of overload relays. Retain one or both subparagraphs below to suit type(s) of motor overload protection.
  5. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
  6. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 3. Indicating Lights: Two of each type and color installed.
  - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
  - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

## 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 Wper controller.

## 1.10 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.  
The effect of solar radiation is not significant.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

## 2.2 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; by Schneider Electric
  - 2. Eaton.
  - 3. Rockwell Automation, Inc.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing, or Reversing as indicated on the Drawings.
- E. Contactor Coils: Pressure-encapsulated type.
  - 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
  - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. Spare CPT Capacity as Indicated on Drawings: 100 VA.
- G. Overload Relays:
  - 1. Thermal Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. Class 10 tripping characteristic.
    - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - d. Ambient compensated.
    - e. Automatic resetting.
  - 2. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor-running overload protection.
    - b. Sensors in each phase.
    - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.



- H. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
- I. Nonfusible Disconnecting Means:
  - 1. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
  - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- J. MCP Disconnecting Means:
  - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
  - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- K. MCCB Disconnecting Means:
  - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
  - 2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

## 2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
    - a. Push-button, shall be heavy-duty, industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall be full-size (30mm). Button color shall be red for EMERGENCY STOP or START and green for STOP. Contact arrangement shall be as required.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

### 3.2 INSTALLATION

- A. Comply with NECA 1.

- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- C. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
  - 2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with drawings and specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, and grounding.
    - d. Verify the unit is clean.
    - e. Inspect contactors:
      - 1) Verify mechanical operation.
      - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
    - f. Motor-Running Protection:
      - 1) Verify overload element rating is correct for its application.
      - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

- h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
  - a. For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
  - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - c. Test motor protection devices according to manufacturer's published data.
  - d. Test circuit breakers as follows:
    - 1) Operate the circuit breaker to ensure smooth operation.
    - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
  - e. Perform operational tests by initiating control devices.
4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
  - a. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
  - b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
  - c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
  - d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
    - 1) Description of equipment to be tested.
    - 2) Discrepancies.
    - 3) Temperature difference between the area of concern and the reference area.
    - 4) Probable cause of temperature difference.
    - 5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
    - 6) Load conditions at time of inspection.
    - 7) Photographs and thermograms of the deficient area.
    - 8) Recommended action.
  - e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
  - f. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable

deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

- C. Motor controller will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.5 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
  - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
  - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
  - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Motor controller will be considered defective if it does not pass the system function tests and inspections.
- C. Prepare test and inspection reports.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 262913.03

## SECTION 262923 - VARIABLE-FREQUENCY 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. Section includes separately enclosed, preassembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. Related Requirements:
  - 1. Section 262505.00 “480V Control Panels” for VFDs installed in control panels.

#### 1.3 DEFINITIONS

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. NC: Normally closed.
- G. NO: Normally open.
- H. NRTL: Nationally Recognized Testing Laboratory
- I. OCPD: Overcurrent protective device.
- J. PID: Control action, proportional plus integral plus derivative.
- K. RFI: Radio-frequency interference.
- L. UL: Underwriters Laboratories
- M. VFC: Variable-frequency motor controller.
- N. VFD: Variable-frequency drive. Used interchangeably with the term VFC.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated.
1. Include dimensions and finishes for VFDs.
  2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  3. Product literature on VFD and all accessories, filters, reactors, control devices, components, etc. Clearly indicate which components or options are being provided.
  4. Drive performance specifications.
  5. True (not displacement) power factor and efficiency curves.
  6. Instruction and replacement parts books.
- B. Shop Drawings: For each VFD indicated.
1. Include mounting and attachment details.
  2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring, including external connections. Show wire and terminal numbers and color coding.
  4. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from the specifications.
  5. Certified shop test reports.
  6. As-built final drawings.
  7. Field test and inspection reports.
  8. The VFD supplier shall submit written verification that the pulse voltage rate of rise will not produce voltage spikes at the motor terminals and that the motor terminal voltage will remain within the motor manufacturer's published data.
  9. The VFD supplier shall submit written confirmation that the motor characteristics (i.e. torque type, FLA, etc.) have been coordinated with the supplier of the driven equipment and that the VFDs being supplied are matched properly for the driven load.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Required working clearances and required area above and around VFDs.
  2. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements.
  3. Show support locations, type of support, and weight on each support.
  4. Indicate field measurements.
- B. Qualification Data: For testing agency.

- C. Product Certificates: For each VFD from manufacturer.
- D. The VFD supplier shall submit written confirmation that the motor characteristics (i.e. torque type, FLA, etc.) have been coordinated with the supplier of the driven equipment and that the VFDs being supplied are matched properly for the driven load.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
    - b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
    - c. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 3. Indicating Lights: Two of each type and color installed.
  - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
  - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

#### 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. Rockwell Automation, Inc.
  - 3. Schneider Electric USA, Inc.
  - 4. Siemens Industry, Inc., Building Technologies Division.
  - 5. Yaskawa Electric America, Inc.

### 2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFDs:
  - 1. VFDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- B. Application: Constant torque.
- C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
  - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed



Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
  3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 66 Hz, with torque constant as speed changes; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
  2. Input AC Voltage Unbalance: Not exceeding 3 percent.
  3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
  4. Minimum Efficiency: 96 percent at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
  6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
  7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
  8. Humidity Rating: Less than 95 percent (noncondensing).
  9. Altitude Rating: Not exceeding 3300 feet.
  10. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  11. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
  12. Speed Regulation: Plus or minus 5 percent.
  13. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
  14. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. 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: 0.1 to 999.9 seconds.
  4. Deceleration: 0.1 to 999.9 seconds.
  5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2.

2. Surge Suppression: Field-mounted surge suppressors complying with UL 1449 SPD, Type 2.
  3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
  4. Under- and overvoltage trips.
  5. Inverter overcurrent trips.
  6. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  7. Critical frequency rejection, with three selectable, adjustable deadbands.
  8. Instantaneous line-to-line and line-to-ground overcurrent trips.
  9. Loss-of-phase protection.
  10. Reverse-phase protection.
  11. Short-circuit protection.
  12. Motor-overtemperature fault.
- K. Automatic Reset/Restart: VFD restarts will be handled via the PLC after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
- L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- M. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. 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.
- O. 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.
- P. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
  2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
  3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
  4. NO alarm contact that operates only when circuit breaker has tripped.

## 2.3 CONTROLS AND INDICATION

- A. Controls shall, as a minimum, perform the control logic indicated on the Contract Drawings and as specified herein.
- B. Status Lights: Door-mounted LED indicators displaying conditions as indicated on the Drawings.

- C. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
  2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    - a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
- D. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
  2. Running log of total power versus time.
  3. Total run time.
  4. Fault log, maintaining last four faults with time and date stamp for each.
- E. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
1. Output frequency (Hz).
  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. PID feedback signal (percent).
  8. DC-link voltage (V dc).
  9. Set point frequency (Hz).
  10. Motor output voltage (V ac).
- F. System Communication:
1. Hardwire, using discrete and analog wiring, for control functions to and from the VFD from the SCADA system. Provide analog 4-20 mA signals for input speed control and output speed reference. These will be optically isolated 4-20 mA DC signals that can be sent to a remote location.
  2. Digital communication to SCADA. Provide a Copper Ethernet for interconnection to the SCADA system. Communication protocol will be Ethernet/IP. All necessary cables, connectors, software, hardware, etc. will be provided as required to interface with the SCADA system.
  3. Provide VFD's with interfacing hardware, software, etc. as required for control and monitoring from the plant computer system. Coordinate and verify compatibility with the plant computer system specified under Division 40 and the VFD's. Submit proof of coordination with Division 40 with the VFD submittals.

4. Turn over interface hardware and software to the Owner at the end of the project.

## 2.4 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Line reactor shall provide 5 percent line impedance at 480 Volts, be capable of 200 percent overload for at least one minute, and will be UL recognized or approved. Line reactors will be installed in the VFD enclosure and factory wired.
- B. DV/DT Output Filter: The filter will be comprised of passive components only. It shall limit peak voltage at the motor terminals to 150% or less of the VFD's DC bus voltage for motor leads of 1000 feet or shorter. The maximum dV/dT of the waveform pulses at the motor terminal will be 200 volts per microsecond. Filter will be UL Listed and have an insertion loss of 3% of rated voltage maximum. Filter will be MTE Series A dV/dT Filter or equivalent.

## 2.5 OPTIONAL FEATURES

- A. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- B. Remote digital operator kit.
- C. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a notebook computer.

## 2.6 ENCLOSURES

- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
  1. Dry and Clean Indoor Locations: Type 12.

## 2.7 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.
  1. Push Buttons: Unguarded.
  2. Pilot Lights: Push to test.
  3. Selector Switches: Rotary type.
  4. Stop and Lockout Push-Button Station: Momentary-break, push-button station.
- B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- D. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.
- E. Spare control-wiring terminal blocks; wired.

## 2.8 ADDITIONAL CONSTRUCTION REQUIREMENTS

- A. Disconnect handle height shall not exceed NEC requirements when VFD is located on 4-inch high housekeeping pad.
- B. VFD's shall utilize 115 VAC control power for operator devices, cooling fans, motor space heaters.
  1. Fused on the primary and secondary.
  2. Isolated from power circuits.
- C. VFD shall include a copper ground bus.
- D. All bus and exposed copper: Tin plated.
- E. All floor mounted enclosures shall have complete 18- inch (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All wall mounted enclosures shall have complete 12- inch (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.
- F. Provide a switchable fluorescent light within each floor mounted section of the enclosure.
- G. Provide barriers on terminals that remain energized with the power disconnect OFF.
- H. Identification
  1. Number all wiring at each end with typed sleeve type labels at each termination. Labels shall correspond to the wiring diagrams. Wiring less than 6 inches may be numbered at only one end.
  2. Provide warning signs on terminals that are energized with the power disconnect OFF.
  3. Provide 2-inch by 5-inch, nominal, engraved three-layer laminated plastic master nameplates on each VFD fastened with stainless steel screws or rivets. Black letters with white background core, 3/8-inch high lettering and shall indicate equipment designation as shown on the Drawings.
  4. Provide legend plates or 1-inch by 3-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.
  5. Provide permanent warning signs as follows:
    - a. "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.
    - b. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT", inside the panel.

## 2.9 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
  - 1. Test each VFD while connected to its specified motor.
  - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.
- B. VFDs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch VFD.
- D. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

- F. Comply with NECA 1.

### 3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
  - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

### 3.4 IDENTIFICATION

- A. Identify VFD's, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each VFD with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Project Officer before starting the motor(s).
  - 5. Test each motor for proper phase rotation.

6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. VFDs will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
  2. Field test all the hardwired discrete and analog connections and any software communication (Ethernet, Profibus, ControlNet, Modbus etc) that are connect to remote control equipment when the VFD is placed in remote. The manufacturer shall at a minimum verify with the proper testing equipment that the following can be achieved:
    - a. The drive can be started and stopped remotely
    - b. The drive can have its speed changed remotely
    - c. The remote equipment can read the VFD discrete status information.
    - d. The remote equipment can read the VFD speed feedback information.

### 3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set the taps on reduced-voltage autotransformer controllers.
- C. Set field-adjustable circuit-breaker trip ranges
- D. Set field-adjustable pressure switches.

### 3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFD's whose interiors have been exposed to water or other liquids prior to Substantial Completion.



3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFD's.

3.10 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.
- B. Replace all cabinet ventilation filters upon commencement of the Contract warranty period.

END OF SECTION 262923



## SECTION 265119 - LED INTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes the following types of LED luminaires:
  - 1. Highbay, nonlinear.
  - 2. Linear industrial.
  - 3. Lowbay.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaires.
  - 4. Include emergency lighting units, including batteries and chargers.
  - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - 6. Photometric data and adjustment factors based on laboratory tests.

- a. **Manufacturers' Certified Data:** Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - b. **Testing Agency Certified Data:** For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. **Shop Drawings:** For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
  2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.
- C. **Product Schedule:** For luminaires and lamps. Use same designations indicated on Drawings.

## 1.5 INFORMATIONAL SUBMITTALS

- A. **Coordination Drawings:** Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
  4. Structural members to which equipment or luminaires will be attached.
  5. Initial access modules for acoustical tile, including size and locations.
  6. Items penetrating finished ceiling, including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Ceiling-mounted projectors.
  7. Moldings.
- B. **Qualification Data:** For testing laboratory providing photometric data for luminaires.
- C. **Product Certificates:** For each type of luminaire.
- D. **Product Test Reports:** For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- E. **Sample warranty.**

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

## 1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## 1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: 41 to 104 deg F.

1. Relative Humidity: Zero to 100 percent.

B. Altitude: Sea level to 1000 feet.

## 2.2 LUMINAIRE REQUIREMENTS

A. Luminaire Types: Furnished as required by the "Lighting Fixture Schedule" on the Drawings. The catalog numbers are given as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers will be acceptable upon approval by the Engineer and shall comply with the additional requirements listed under Part 2.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Factory-Applied Labels: Comply with UL 1598. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles.

1. Label shall include the following lamp characteristics:

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

## 2.3 HIGHBAY, NONLINEAR.

A. Lamp:

1. Minimum 3,000 lumens.
2. Minimum allowable efficacy of 80 lumens/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Internal driver.
6. User-Replaceable Lamps:

- a. Bulb shape complying with ANSI C78.79.
- b. Lamp base complying with ANSI C81.61.

7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

B. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

C. Standards:

1. ENERGY STAR certified.

2. RoHS compliant.

## 2.4 LOWBAY

### A. Lamp:

1. Minimum 3,000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:
  - a. Bulb shape complying with ANSI C78.79.
  - b. Lamp base complying with ANSI C81.61.
8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

### B. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

## 2.5 MATERIALS

### A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

### B. Steel:

1. ASTM A 36/A 36M for carbon structural steel.
2. ASTM A 568/A 568M for sheet steel.

### C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A 240/240 M.

### D. Galvanized Steel: ASTM A 653/A 653M.

## 2.6 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.7 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gauge.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 TEMPORARY LIGHTING

- A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

### 3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
  - 1. Sized and rated for luminaire weight.



2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Ceiling-Mounted Luminaires:

1. Attached using through bolts and backing plates on either side of ceiling.
2. Match existing mounting supports.

E. Suspended Luminaires:

1. Ceiling Mount:
  - a. Pendant mount with 5/32-inch-diameter aircraft cable supports adjustable to 10 feet in length.
  - b. Hook mount.
2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace drivers or luminaires that are defective.
  2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  3. Adjust the aim of luminaires in the presence of the Engineer or Engineer

END OF SECTION 265119

## SECTION 316329 - DRILLED CONCRETE PIERS AND SHAFTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for concrete related materials.

#### 1.3 DEFINITIONS

- A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
  - 1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time are authorized for removal of obstructions.
- B. Production Pier: Pier installed at a permanent pier location, which becomes part of permanent structure.
- C. Obstruction: Impenetrable objects that cannot be removed or excavated using conventional rock or soil augers, drilling buckets, casing twistors, and cause a sudden and significant decrease in the rate of excavation advancement as compared to before the obstruction was encountered or shafts in close proximity advanced using the same techniques and equipment.
  - 1. Man-made materials may include remnant concrete foundations encountered at a depth greater than 10 feet below ground surface that cannot be removed after reasonable effort or whose removal would threaten integrity of adjacent structures or completed drilled shaft installations.
  - 2. Sloping bedrock or bedrock that is encountered at a shallower elevation than anticipated shall not be considered as obstruction.
- D. Defective Drilled Shafts: Those exhibiting flaws that result in inadequate performance (deflection criteria) or unsafe performance (capacity criteria) under the shaft design loads, as determined by the Engineer, based on shaft construction records.

- E. Professional Engineer: Professional Engineer licensed in the Commonwealth of Virginia meeting project qualifications and who is hired by Contractor.
- F. Professional Surveyor: Professional Surveyor licensed in the Commonwealth of Virginia meeting project qualifications and who is hired by Contractor.
- G. Professional Geotechnical Engineer: Professional Geotechnical Engineer licensed in the Commonwealth of Virginia meeting project qualifications and who is hired by Contractor.
- H. The Engineer: The Engineer or designated representative hired by Owner.
  - 1. Approval given by the Engineer shall not relieve Contractor of its responsibilities for performing the work in accordance with Contract Document requirements.
- I. Special Inspection Engineer: Entity hired by Owner to perform special inspections related to pile installations.
  - 1. Approval given by Special Inspection Engineer shall not relieve Contractor of its responsibilities for performing the work in accordance with Contract Document requirements.

#### 1.4 ACTION SUBMITTALS

- A. Submit for review and acceptance in accordance with Section 013300 “Submittal Procedures”, product data and shop drawings showing materials of construction, installation equipment, and details of installation.
- B. Product Data: For each type of product.
- C. Design Mixtures: For each concrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
  - 2. Include concrete mixing and placement procedures.
  - 3. Identify slurry design, if needed.
    - a. Slurry Design: Mix design, criteria for density, viscosity, and pH, methods to mix, circulate, de-sand, maintain and dispose of slurry, and including control testing procedures.
- D. Shop Drawings: For equipment and installation procedures, concrete reinforcement, detailing fabricating, bending, supporting, and placing.
  - 1. Submit numbering plan and sequence of drilled shaft construction as it relates to overall construction plan and sequence of shaft construction.
  - 2. Submit equipment and installation procedures, including;
    - a. List of equipment with specification and catalog data, including cranes, drills, augers, bailing buckets, casing oscillators, casing twistors, vibratory hammers,

- final cleaning equipment, de-sanding equipment, slurry pumps, core sampling equipment, testing equipment, tremies or concrete pumps, casing, etc.
- b. Details of shaft excavation methods in soils and rock (if encountered), including addressing sloping bedrock and methods of removing obstructions such as boulders or foundations.
  - c. Procedure for temporary casing installation and removal.
  - d. Method to perform final cleaning of excavation and checking the cleanliness and soundness of rock socket sidewalls and bearing surface.
  - e. Methods and materials for filling or eliminating voids between the plan shaft diameter and excavated pier diameter.
  - f. Details of proposed methods for ensuring drilled shaft stability during excavation and concrete placement and to prevent loss of ground beyond the specified diameter.
  - g. Method of monitoring plumbness and location of the shaft during construction.
  - h. Disposal plan for excavated material, slurry, water, or contaminated concrete expelled from the top of the shaft.

#### 1.5 DELEGATED DESIGN SUBMITTAL

- A. Geotechnical design report sealed, signed and dated by a Professional Geotechnical Engineer licensed in the Commonwealth of Virginia. The geotechnical design report shall include at a minimum the following:
  1. Boring location plan,
  2. Typed boring log for each shaft location,
  3. Summary of subsurface investigation methodologies,
  4. Summary of subsurface and groundwater conditions,
  5. Drilled pier foundation design recommendations assuming no drilled pier load test (i.e., higher factor of safety to account for lack of load test),
  6. Design groundwater level and uplift considerations (if required),
  7. Seismic site class, and
  8. Construction considerations related to drilled pier installation.
- B. Foundation design drawing and calculations sealed, signed and dated by a Professional Engineer licensed in the Commonwealth of Virginia.
- C. Propose corrective action plan for shafts with identified defects.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
  1. Contractor, Installer, project supervisor, and drill operators.
  2. Contractor's Professional Geotechnical Engineer, Professional Engineer (if different than Professional Geotechnical Engineer), and Professional Surveyor.
- B. Material Certificates: From manufacturer, for the following:
  1. Cementitious materials.

2. Admixtures.
  3. Steel reinforcement and accessories, including steel type, chemical content, and physical properties including yield strength.
- C. Material Test Reports: For each material below, by a qualified testing agency:
1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- D. Field quality-control reports.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Record Documents: Submit a type-written and signed record of each installed pier. Include pier designation number, pier diameter, pier casing length installed, date and time of installation, time delays during installation, cut-off and tip or bell elevations, depth of pier penetration into rock (if required), time and type of concrete placement, deviations from drawing location and from plumb, and other applicable data.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Installer that has specialized in drilled-pier work having minimum of 5 years' experience including experience with similar subsurface materials, water conditions, pier sizes, and special techniques required.
- B. On-Site Supervisor Qualifications: Have at least five years of experience in drilled shaft construction.
- C. Drill Operators Qualifications: Have at least three years of experience.
- D. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated.
- E. Professional Surveyor Qualifications: Licensed in Commonwealth where project exists and who determines and certify actual locations of each installed pier. Submit certified lists and drawings of pier locations with pier designation numbers, tip and cutoff elevations, and deviations from plumb.
- F. Professional Geotechnical Engineer or Professional Engineer Qualifications: Individual licensed in Commonwealth where the project work site is located, having 10 years' experience in drilled shaft design and installation, who is employed by Contractor and who shall stamp and seal Shop Drawings, structural design calculations, and other relevant pier design information. Have minimum of three successfully completed projects over past five years with drilled shaft foundation of similar size, construction and in similar ground conditions.
- G. Within 2 working days after any pier has been deemed to be permanently obstructed or when an installed pier has been observed to exceed specified tolerances, provide the Engineer with a sketch showing installed pier locations immediately adjacent to the pier.
- H. Certified Piers Survey: Submit within seven days of completion.

1. Include plan layout of installed piers with horizontal and vertical locations of pier tops. Include horizontal offset dimensions of each pier from design location.
  2. Show pier designation numbers and locations with respect to specified tolerances.
  3. Reference locations to established building lines as indicated on Drawings.
  4. Provide top of reinforcement elevations for each pier, prior to pier top preparation.
- I. Field quality-control reports.
- J. Record Drawings.
- K. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- 1.9 DELIVERY, STORAGE AND HANDLING
- A. Store casings off the ground and protect to maintain its roundness within 2 percent of casing diameter.
- B. Handle casings to minimize damage and to maintain its shape.
- C. Lift pile reinforcing using a cradle or multiple point pick-up system to ensure that reinforcing is undamaged during lifting and placement.
1. Repair any damaged reinforcing prior to installation.
- 1.10 FIELD CONDITIONS
- A. Project Information: A geotechnical design report has not been prepared for this Project.
1. Engage a Professional Geotechnical Engineer to prepare a geotechnical design report. Perform test borings and conduct other exploratory operations necessary according to the performance requirements.
  2. Groundwater levels may vary during the work.
- B. Survey Work: Engage a Professional Surveyor or Professional Engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
1. Record and maintain information pertinent to each drilled pier and indicate on record Drawings. Cooperate with Owner's testing and inspecting agency to provide data for required reports.
- C. Coordinate with the Owner for working hour limitations for drilling operations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Drilled-Pier Standard: Comply with ACI 336.1 for all system materials, except as modified in this Section.
- B. Drilled Pier:
  - 1. Engage a Professional Geotechnical Engineer to provide the final design of the drilled shafts shown on the drawings.
    - a. Design to consider soil-structure interaction.
    - b. The professional geotechnical engineer shall provide recommendations for construction methods such as, uncased, temporary casing, or slurry methods.
  - 2. Design piers for the axial, flexural, and lateral capacities as indicated on the Drawings.
  - 3. Lateral Displacement of the Top of the Pier: Limited to ¼” maximum.

### 2.2 MATERIALS - STEEL REINFORCEMENT

- A. Refer to requirements in Section 032000 “Concrete Reinforcing”.

### 2.3 MATERIALS - CONCRETE

- A. Refer to requirements in Section 033000 “Cast-in-Place Concrete”:
  - 1. Concrete: Conform to Class A.
  - 2. Tremie Concrete: Conform to Class B.

### 2.4 MATERIALS - SLURRY

- A. Slurry: Pulverized bentonite, pulverized attapulgite, or polymers mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH.

### 2.5 CONCRETE MIXING

- A. Refer to requirements in Section 033000 “Cast-in-Place Concrete”:
  - 1. Non-Tremie Concrete: Conform to Class A.
  - 2. Tremie Concrete: Conform to Class B.



## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Prior to commencing with the Work in this Section, carefully examine job site and verify that piers can be installed in accordance with Contract Documents. Verify that site conditions will support pier installation equipment. Verify that adequate space is available to safely lift and install the piers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled pier operations.
  - 1. Repair damage to adjacent structures and construction due to drilled pier installation without additional compensation.
- B. When piers are located in an area where site grading is required, complete grading prior to performing work of this Section.

### 3.3 GENERAL

- A. Install drilled piers to following criteria:
  - 1. Depth: As required per the soil and/or rock conditions but not less than 18 feet..
  - 2. Pier Shafts: Concrete, reinforced.
  - 3. Pier Bottoms: Non-belled.
  - 4. Permanent Steel Casings: Not used.
- B. Provide temporary casing of proper diameter, length and thickness, and other required safety equipment. Comply with applicable building codes, laws, or regulations for inspection and testing of drilled piers.
- C. Coordinate drilling operations and concrete placement. Do no drilling within 20 feet where concrete is being placed or where concrete is less than 48 hours old.
- D. For defective drilled shafts, submit a plan for remedial action to the Engineer for acceptance. Modifications to structural integrity or load transfer mechanism caused by remedial action shall require new calculations and drawings stamped by a Professional Engineer. Perform remedial work without additional compensation.

### 3.4 EXCAVATION

- A. Perform excavation on an unclassified basis.

- B. Excavate drilled pier as close as practicable to design locations, dimensions, and elevations shown or as directed. Extend drilled pier tip elevations when the Engineer determines that the material encountered during excavation is unsuitable or differs from that anticipated in the design of the drilled pier.
- C. Maintain stability of pier sidewalls during drilling operations, which may require excavation below water level, excavation within a steel casing, or excavation utilizing a slurry operation. Where caving conditions or excessive groundwater is encountered, do no further drilling until a construction method acceptable to the Engineer is employed.
- D. When bottom of excavation is a sloping rock surface, excavate to a level plane or a step with a maximum height less than 1/4 the width or diameter of bearing area.
- E. Remove or cleared obstructions by excavation, drilling, chipping or other approved means. Do not use blasting or jetting methods.
- F. Minor raising of foundation elevation may be approved by the Engineer. If satisfactory material is not encountered at specified elevation or depth, the bottom of any drilled hole may be lowered after receiving written approval from the Engineer.
- G. Perform drilled pier excavation using casing construction method or wet method with drilling fluid or slurry.
- H. Dry excavation method is only allowed when a trial shaft excavation demonstrates that:
  - 1. Less than 3 inches of water accumulated above the base over a one-hour period without pumping.
  - 2. Sides and bottom of the hole remain stable without caving and sloughing over a four-hour period following completion of excavation.
  - 3. Loose material or water can be removed prior to inspection and concrete placement.
- I. Slurry Displacement Method - Excavation: Stabilize excavation with slurry maintained a minimum of 60 inches above groundwater level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.
  - 1. Excavate and complete concreting of drilled pier on same day, or re-drill, clean, and test slurry in excavation before concreting.
- J. If top elevation of pier is below ground level at time of concrete placement, provide an oversized casing from ground elevation to a point below top of the shaft to control caving of any material into freshly placed concrete.
  - 1. Contractor will be permitted to backfill with pea gravel or other granular material around upper portion of casing at no additional cost to Owner. Provide a space to allow for escape of muck, slurry, or water displaced by concrete.
- K. After completion of drilled pier excavation and prior to reinforcing steel cage and concrete placement, machine clean slough and other loose material from the pier.
  - 1. Where slurry or groundwater is not present, clean dry excavations with flight auger or other equipment as approved by the Engineer.

2. Where slurry or groundwater is present, clean excavation with an air lift, bucket auger, or similar type of equipment as approved by the Engineer.
- L. Cover open excavations that are potentially hazardous when work is not occurring on them. Cover open excavations at end of each shift.
- M. Prevent surface water from entering excavated piers. Direct surface water to site drainage facilities.
- N. Excavate drilled piers to indicated elevations. Remove loose material from bottom of excavation. No more than 1 inch of loose material shall remain at bottom of the excavation.
  1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
  2. Remove water from excavated shafts before concreting.
  3. Excavate rock sockets (if required) of dimensions indicated.
- O. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by the Engineer.
  1. Do not excavate piers deeper than elevations indicated, unless approved by the Engineer.
  2. Payment for additional authorized excavation is according to Contract provisions for changes in the Work.
- P. End-Bearing Drilled Piers: Probe with auger to a depth below bearing elevation, equal to diameter of drilled pier bearing area. Determine whether voids, clay seams, or solution channels exist.
  1. Test each drilled pier.
  2. Fill auger-probe holes with grout.
- Q. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into pier; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of pier walls.
  1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete, or leave temporary casings in place.

### 3.5 SHAFT INSPECTION

- A. Provide suitable equipment and facilities so the Engineer may inspect completed drilled pier excavations and check for alignment and dimensions.
- B. Provide suitable access and lighting for proper inspection of completed drilled pier shaft prior to concrete placement.
- C. Check bearing surface by sounding in presence of the Engineer immediately before placement of concrete.
- D. Do not place reinforcing steel and concrete in drilled shaft excavation until the Engineer has made an inspection and given approval.

### 3.6 INSTALLATION - SLURRY

- A. Provide a specialist experienced in slurry drilling to design and monitor the slurry when used to maintain an excavation. Use slurry consisting of a stable suspension of commercial materials in water with a minimum density to maintain the excavation. Monitor slurry properties, including but not limited to density, viscosity, pH, and sand content, for conformance to submitted design criteria during drilling operations.
  - 1. Contractor remains responsible for slurry design and control, as well as resulting drilled pier foundation produced by this method.
- B. Thoroughly mix slurry before placing into an excavation. Dry material placed in an excavation and mixed with water by a drilling auger will be rejected.
- C. Feed slurry into excavations as drilling progresses, keeping holes filled to the top or maintained within any casing.
- D. Slurry ejected during concrete placement may be reused provided it is screened to remove gravel chips or other granular materials.
- E. Conduct tests on slurry immediately prior to reinforcing steel placement. Include samples obtained from bottom of excavation to establish conformance with submitted criteria. Adjust slurry consistency to maintain the excavation and to provide a suitable environment for concreting operation.

### 3.7 INSTALLATION - STEEL REINFORCEMENT

- A. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
- B. Fabricate cage of reinforcing steel consisting of longitudinal bars and spiral reinforcement or lateral ties, completely assembled and tied.
- C. If pier requiring full depth reinforcement is lengthened, bars may be lap spliced, spliced by butt welding, or connected by other procedures approved by the Engineer. Position splices in lower portion of pier.
- D. Install reinforcing cages symmetrically about axis of piers as a single unit, immediately prior to concrete placement.
- E. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.
- F. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
  - 1. Position approved plastic spacers along cage or pier to ensure concentric spacing of reinforcement. Position spacers and ties allowing clearance for concrete placement and tremie pipes.

- G. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

### 3.8 INSTALLATION - CONCRETE

- A. Place concrete in continuous operation and without segregation immediately after inspection and approval of pier with reinforcing steel by a qualified Special Inspector.
  - 1. Continuously place concrete in pier.
- B. Concrete: Be workable, requiring minimal vibrating or rodding. Exercise care during placement to prevent honeycombs and air pockets from forming in concrete.
- C. Sound bottom of pier immediately before placing concrete.
- D. Start concrete placement within 2 hours after excavation has been completed and approved and steel reinforcement has been placed and approved.
  - 1. Reinspect, clean and reset, steel reinforcement cage, re-clean pier bottom and recirculate slurry prior to concrete placement if placement is not begun in 2 hours.
- E. Place concrete in dry excavations and under slurry or water in accordance with Section 033000 "Cast-In-Place Concrete."
- F. If pier cannot be pumped free of seepage water, place concrete with tremie pipe or pump hose continuously from the bottom of the pier to top.
- G. Place concrete in slurry-filled piers by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no less than 60 inches into concrete and that flow of concrete is continuous from bottom to top of drilled pier.
- H. Tremie pipe or pump lines used for placement in slurry or water shall be watertight and fitted with a plug, valve, or similar device to separate concrete and fluid in the pier until sufficient head buildup.
- I. Cut-off piers at required elevation on a clean and true horizontal plane unless otherwise indicated. Continue to chip back concrete until resulting surface is sound and uncontaminated.
- J. Stop concrete placement above final cut-off elevation shown after fluids, waste, and laitance have been discharged from pier.
- K. Dry Method: Only permitted in dry excavation with no more than 3 inches of water within pier. Place concrete to fall vertically down the center of drilled pier without striking sides of pier or steel reinforcement.
  - 1. Free fall height shall not exceed 5 feet.
  - 2. Where concrete cannot be directed down pier without striking reinforcement, place concrete with chutes, tremies, or pumps.
  - 3. Vibrate top 60 inches of concrete.

4. If concrete placement causes the pier excavation to cave or slough, or if the concrete strikes the rebar cage or side wall, the Contractor shall reduce the height of free fall or reduce the rate of concrete flow into the excavation, or both
  5. If placement cannot be satisfactorily accomplished by free fall in the opinion of the Engineer, the Contractor shall use either tremie or pumping to accomplish the placement of cement concrete
- L. Screen concrete at cutoff elevation level and apply scoured, rough finish. Chip back concrete until resulting surface is sound and uncontaminated. Where cutoff elevation is above the ground elevation, form top section above grade and extend pier to required elevation.
- M. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.
- N. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 degrees F.
1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.
- O. Do not place concrete or allow concrete less than 48 hours old to be within 20 feet of any pier drilling operation.

### 3.9 CASING REMOVAL

- A. Do not exceed one hour elapsed time from beginning of concrete placement in cased portion of shaft until beginning casing extraction.
- B. Start casing removal after level of fresh concrete within casing reached at least 10 feet in depth.
- C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least 5 feet head of concrete above bottom of casing, except at top of pier.
1. Vibrate top 5 feet of concrete after withdrawal of temporary casing.
- D. Remove contaminated concrete from pier.
- E. If casing removal causes movement of concrete or reinforcing steel, comply with following:
1. Upward Movement That is 3 inch: Continue pulling casing, provided no further movement occurs and vibrating or rodding is used to reconsolidate the concrete. Do not vibrate or rod concrete in an attempt to break casing loose for extraction.

2. Upward Movement That is Greater Than 3 inch: Leave casing in place as a permanent sleeve at Contractors expense.

### 3.10 TOLERANCES

- A. Perform drilled pier related work in compliance with specified tolerances:
  1. Maximum Lateral Deviation from Plan Cut-Off Location: 3 inches.
  2. Deviation from Design Cut-Off Elevation: Do not exceed plus 1 inch to minus 3 inches.
  3. Out-of-Plumb: Maximum 2 percent of shaft length.
  4. Pile Top at Cut-Off Elevation: Free of defects and level with a full cross section of specified diameter.
- B. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to the Engineer for review before proceeding.
- C. Variation of pier location within indicated limits shall not be cause for variation in anchor bolt or pier cap location.

### 3.11 PIER ACCEPTANCE

- A. Only piers meeting the requirements of this Section shall be accepted for payment.
- B. When piers are installed with dimensions outside of the specified tolerances, with concrete not meeting the specified strength, or with any other non-conforming condition, the Engineer will make a determination regarding the proper corrective measures to be taken, which may include:
  1. Removal and replacement of defective piers.
  2. Installation of additional piers at nearby locations.
  3. Modification of the foundation over the pier.
  4. Other measures the Engineer deems appropriate.
- C. The Engineer may require a load test to determine drilled pier adequacy and acceptability.
- D. Perform corrective measures ordered by the Engineer without additional compensation. In addition, pay for required testing, additional engineering costs for the evaluation and re-design, and additional review by the Engineer.

### 3.12 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  1. Drilled piers.
  2. Excavation.
  3. Concrete.
  4. Steel reinforcement.

- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled pier lengths and bearing capacities are determined by testing and inspecting agency. Final evaluations and approval of data are determined by the Engineer.
- D. Concrete Tests and Inspections: ASTM C172/C172M except modified for slump to comply with ASTM C94/C94M.
1. Slump: ASTM C143/C143M; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
  2. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 degrees F and below and 80 degrees F and above, and one test for each set of compressive-strength specimens.
  3. Compression Test Specimens: ASTM C31/C31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
    - a. Take one set of four test cylinders per pier and maximum of one set per truckload.
  4. Compressive-Strength Tests: ASTM C39/C39M; one set for each drilled pier but not more than one set for each truck load. Test one specimen at seven days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
  5. If frequency of testing provides fewer than five strength tests for a given class of concrete, conduct tests from at least five randomly selected batches or from each batch if fewer than five are used.
  6. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  7. Strength of each concrete mixture is satisfactory if every average of any three-consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
  8. Report test results in writing to the Engineer, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
  9. Non-Destructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer but not be used as sole basis for approval or rejection of concrete.
  10. Additional Tests: Testing and inspecting agency to make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by the Engineer.



- a. Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.
11. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports for each drilled pier as follows:
  1. Actual top and bottom elevations.
  2. Actual drilled-pier diameter at top and bottom.
  3. Top of rock elevation (if encountered).
  4. Description of soil and rock (if encountered) materials.
  5. Description, location, and dimensions of obstructions.
  6. Final top centerline location and deviations from requirements.
  7. Variation of shaft from plumb.
  8. Shaft excavating method.
  9. Design and tested bearing capacity of bottom.
  10. Depth of rock socket.
  11. Levelness of bottom and adequacy of cleanout.
  12. Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.
  13. Groundwater conditions and water-infiltration rate, depth, and pumping.
  14. Description, purpose, length, wall thickness, diameter, and tip elevations of temporary casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
  15. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
  16. Date and time of starting and completing excavation.
  17. Inspection report.
  18. Condition of reinforcing steel and splices.
  19. Position of reinforcing steel.
  20. Concrete placing method, including elevation of consolidation and delays.
  21. Elevation of concrete during removal of casings.
  22. Locations of construction joints.
  23. Concrete volume.
  24. Concrete testing results.
  25. Remarks, unusual conditions encountered, and deviations from requirements.

### 3.13 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, debris, shaft wastewater, slurry, and other material resulting from pier installations.

- B. Legally dispose of surplus and waste materials off Owner's property.

END OF SECTION 316329

## SECTION 321623 - SIDEWALKS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes: Concrete paving for sidewalks.
- B. Related Requirements:
  - 1. Section 033000 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frames, slabs on fill or grade, and other concrete components.

#### 1.3 PREINSTALLATION MEETINGS

- A. Section 013100 "Project Management and Coordination" for requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

#### 1.4 SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.
- B. Product Data:
  - 1. Submit required information regarding concrete materials, joint filler.
  - 2. Mix Design:
    - a. Submit concrete mix design for each concrete strength prior to commencement of Work.
    - b. Submit separate mix designs if admixtures are required for hot- and cold-weather concrete Work.
    - c. Identify mix ingredients and proportions, including admixtures.
  - 3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Source Quality-Control Submittals: Indicate results of shop or factory tests and inspections.

- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

#### 1.5 QUALITY ASSURANCE

- A. Perform Work according to Sections 033000 “Cast-in-Place Concrete.”
- B. Obtain cementitious materials from same source throughout.
- C. Perform Work according to Arlington County Design Standards and Guidelines Horizontal Standard H-3.9 – Sidewalks.
- D. Maintain 1 copy of each standard affecting Work of this Section on Site.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 3 years’ experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 “Product Requirements” for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.

#### 1.8 AMBIENT CONDITIONS

- A. Section 015000 “Temporary Facilities and Controls” for requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions: Do not place concrete if base surface temperature is less than 40 deg. F, or if surface is wet or frozen.

- C. Subsequent Conditions: Maintain minimum 50 deg. F, for not less than 72 hours after placing, and at a temperature above freezing for remainder of curing period.

## 1.9 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 AGGREGATE SUBGRADE

- A. Subgrade shall be excavated 1-ft below finished grade, compacted and filled with minimum 6-inches of compacted gravel unless specified otherwise by the Arlington County Design Standards and Guidelines Horizontal Standard H-3.9 - Sidewalks.
  - 1. Contractor is responsible for avoiding and protecting buried utilities.

### 2.2 MATERIALS

- A. Forms:
  - 1. Material:
    - a. Wood: Straight and free from warping, twisting, loose knots, splits, or other defects.
    - 2. Profile: To suit conditions.
    - 3. Joint Filler:
      - a. Material: Asphalt-impregnated fiberboard or felt.
      - b. Comply with ASTM D1751.
      - c. Thickness: 1/4 inch
- B. Reinforcement:
  - 1. Reinforcing Steel and Wire Fabric: As specified in Section 033000 "Cast-in-Place Concrete."
- C. Concrete:
  - 1. Concrete Materials:
    - a. As specified in Section 033000 "Cast-in-Place Concrete."

## 2.3 FABRICATION

### A. Reinforcing:

1. Comply with CRSI Manual of Practice.

### B. Hooks:

1. As indicated on Drawings.
2. Type:
  - a. Standard 180-degree or 90-degree bends.
  - b. Seismic.

## 2.4 MIXES

### A. Concrete:

1. Comply with ASTM C94/C94M, Option A.

## 2.5 FINISHES

### A. Reinforcement:

1. Galvanized Finish for Steel Bars:
  - a. Comply with ASTM A767/A767M.
  - b. Class: I.
  - c. Hot-dip galvanized after fabrication.
2. Epoxy-Coated Finish for Steel Bars: Comply with ASTM A775/A775M
3. Epoxy-Coated Finish for Steel Wire:
  - a. Comply with ASTM A884/A884M.
  - b. Class A, using ASTM A775 or A775M

## 2.6 ACCESSORIES

### A. Curing Compound:

1. Comply with ASTM C309.
2. Type: 1
3. Class: A

### B. Joint Sealers:

1. The expansion joint material shall conform to the requirements of ASTM D-1751.

## 2.7 SOURCE QUALITY CONTROL

- A. Section 014000 “Quality Requirements” for requirements for testing, inspection, and analysis.
- B. Testing: Comply with ASTM C94/C94M

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017300 “Execution” for requirements for installation examination.
- B. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- C. Verify that gradients and elevations of subgrade are as indicated on Drawings.
- D. Verify reinforcing placement for proper size, spacing, location, and support.

### 3.2 PREPARATION

- A. Section 017300 “Execution” for requirements for installation preparation.
- B. Moisten substrate to minimize absorption of water from fresh concrete.
- C. Notify Engineer minimum 24 hours prior to commencement of concreting operations.

### 3.3 INSTALLATION

- A. Concrete Sidewalks: 3000-psi 28-day concrete, 4 inches thick, buff color portland cement, exposed aggregate finish.
  1. Sidewalk: 48-inches wide except where limited by odor control duct supports.
  2. Sidewalk: Flush where abutting existing sidewalk and Manhole curbing.
- B. Subgrade:
  1. Comply with Arlington County Design Standards and Guidelines Horizontal Standard H-3.9 - Sidewalks.
- C. Forms:
  1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
  2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
  3. Wood Forms: Thoroughly wet with water before concrete is placed.

D. Reinforcement:

1. Place reinforcing at top and bottom of paving.
2. Interrupt reinforcing at expansion joints.
3. Place reinforcing to achieve indicated paving alignment.

E. Placing Concrete:

1. As specified in Section 033000 "Cast-in-Place Concrete."

F. Joints:

1. Place continuous transverse expansion joints at 5-foot intervals or width of sidewalk, whichever is less.
2. Filler:
  - a. Place joint filler between paving components and building or other appurtenances.
  - b. Recess top of filler 1/4 inch for sealant installation.
3. Provide scored joints at 3-foot intervals between sidewalks and adjacent concrete structures.

G. Exposed Aggregate:

1. Apply surface retarder where exposed aggregate finish is required.
2. Wash exposed aggregate surface with clean water and scrub with stiff bristle brush, exposing aggregate.

H. Finishing:

1. Light broom to trowel edges of joints.
2. Texture Direction: Transverse to paving direction.
3. Place sealer on exposed concrete surfaces immediately after finishing.
4. Edges and Joints:
  - a. Edger Radius: 1/8 inch.
  - b. Spalled Corners and Edges: Clean and fill with mortar mixture and finish.

I. Curing:

1. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
2. Mats:
  - a. Cover exposed surface with two or more layers of wetted burlap, overlapping each other minimum 6 inches
  - b. Maintain burlap continuously saturated and in contact with concrete for minimum seven days.



- J. Backfilling: After curing, backfill, grade, and compact adjacent disturbed area. Adjacent disturbed areas to be restored to existing conditions.

### 3.4 TOLERANCES

- A. Section 014000 "Quality Requirements" for requirements for tolerances.
- B. Maximum Variation of Surface Flatness: 1/4 inch in 10 feet.
- C. Maximum Variation from True Position: 1/4 inch.
- D. Line and Grade for Forms: 1/8 inch in any 10-foot-long section.

### 3.5 FIELD QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for inspecting and testing.
- B. Inspection and Testing:
  - 1. Comply with ASTM C94/C94M.
  - 2. Samples:
    - a. Sampling Procedures: Comply with ASTM C172/C172M.
    - b. Cylinder Molding and Curing Procedures: Comply with ASTM C31/C31M, standard cured.
    - c. Sample concrete and make one set of three cylinders for every 75 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area paving.
    - d. Make one additional cylinder during cold-weather concreting, and field cure.
  - 3. Cylinder Compressive Strength:
    - a. Comply with ASTM C39/C39M.
    - b. Acceptance:
      - 1) Average Compressive Strength of Three Consecutive Tests: Maximum 500 psi less than specified compressive strength.
  - 4. Slump, Temperature, and Air Content:
    - a. Measure for each compressive-strength concrete sample.
    - b. Slump: Comply with ASTM C143/C143M.
    - c. Air Content: Comply with ASTM C173/C173M or C231/C231M.
    - d. Temperature: Comply with ASTM C1064/C1064M.
  - 5. Records:
    - a. Maintain records of placed concrete items.

- b. Record date, location of pour, quantity, air temperature, number of test samples taken.

### 3.6 PROTECTION

- A. Section 017300 "Execution" for requirements for protecting finished Work.
- B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, rain and flowing water, and mechanical injury.
- C. Do not permit traffic over paving for minimum 7 days after finishing.
- D. Damaged Concrete:
  1. Remove and reconstruct concrete that has been damaged for entire length between scheduled joints.
  2. Refinishing damaged portion is not acceptable.
  3. Dispose of damaged portions.

END OF SECTION 321623

## SECTION 400506 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:

1. Pipe penetrations.
2. Restrained joints.
3. Flexible connections.
4. Expansion joints.
5. Expansion loops.
6. Sleeve-type couplings.

- B. Related Requirements:

1. Section 099000 "Painting and Coating" for product and execution requirements for painting specified by this Section.
2. Section 400507 "Hangers and Supports for Process Piping" for hangers, anchors, sleeves, and sealing of piping to adjacent structures.
3. Section 400519 "Ductile Iron Process Pipe" for ductile-iron piping materials and appurtenances.
4. Section 400523 "Stainless Steel Process Pipe and Tubing" for stainless steel piping materials and appurtenances.
5. Section 400531 "Thermoplastic Process Pipe" for plastic piping materials and appurtenances
6. Section 400551 "Process Valves" for common product requirements for valves for placement by this Section.
7. Section 404213 "Process Piping Insulation" for piping insulation as required by this Section.
8. Section 404113 "Process Piping Electrical Resistance Heat Tracing."

### 1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): The sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire-rated construction.
- B. FM: Factory Mutual Insurance Company; FM Global is the communicative name of the company.
- C. WH: Warnock Hersey; indicates compliance to relevant building codes, association criteria, and product safety and performance standards.

#### 1.4 COORDINATION

- A. Section 013100 “Project Management and Coordination” for requirements for coordination.
- B. Coordinate Work of this Section with installation of piping, valves and equipment connections specified in other Sections and indicated on Drawings.

#### 1.5 SUBMITTALS

- A. Product Data:
  - 1. Submit manufacturer catalog information for each specified product, including installation instructions.
  - 2. Firestopping: Submit data on product characteristics, performance, and limitation criteria.
  - 3. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  - 4. Expansion Joints: Indicate maximum temperature, pressure rating, and expansion compensation.
- B. Shop Drawings:
  - 1. Identification:
    - a. Submit list of wording, symbols, letter size, and color coding for pipe identification.
    - b. Comply with ASME A13.1.
  - 2. Indicate restrained joint details and materials.
  - 3. Submit layout drawings showing piece numbers and location, indicating restrained joint locations.
  - 4. Indicate layout of piping systems, including flexible connectors, expansion joints and compensators, loops, offsets, and swing joints.
- C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings for maintenance of fire-resistance rating of adjacent assembly.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying ASME qualification within previous 12 months.
- F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for:
  - 1. Flexible connectors
  - 2. Expansion joints
  - 3. Pipe Restraints:
    - a. Determine restrained lengths and submit joint restraint details.

- b. Use joint restraint devices specifically designed for applications as described in manufacturer data.
- 4. Firestopping Engineering Judgments: For conditions not covered by UL- or WH-listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction to accept as meeting fire-protection code requirements.
- G. Manufacturer Instructions: Submit special procedures and setting dimensions.
- H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- J. Qualifications Statements:
  - 1. Submit qualifications for manufacturer, installer, and licensed professional.
  - 2. Submit manufacturer's approval of installer.
  - 3. Welders: Qualify procedures and personnel according to ASME BPVC-IX
  - 4. American Iron and Steel (AIS): Submit certification indicating compliance with requirements.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Section 017000 "Execution and Closeout Requirements" for requirements for submittals.
- B. Project Record Documents: Record actual locations of piping appurtenances.
- C. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

#### 1.7 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.
- B. Perform Work according to ASME B31.9 for installation of piping systems and according to ASME BPVC-IX for welding materials and procedures.
- C. Perform Work according to ASME B31.3, ASME B31.9, and applicable local code for installation of piping systems.
- D. Through-Penetration Firestopping of Fire-Rated Assemblies:
  - 1. Comply with ASTM E814.
  - 2. Minimum Positive Pressure Differential: 0.1-inch wg to achieve fire F-ratings and temperature T-ratings as indicated on Drawings, but not less than one hour.
  - 3. Wall Penetrations: Fire F-ratings as indicated on Drawings, but not less than one hour.
  - 4. Floor and Roof Penetrations:
    - a. Fire F-ratings and Temperature T-ratings: As indicated on Drawings, but not less than one hour.
    - b. Floor Penetrations within Wall Cavities: T-rating is not required.

- E. Perform Work according to Arlington County standards.

## 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum **five** years' [ experience.
- C. Welders: ASME qualified within previous 12 months for employed weld types.
- D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Virginia.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
  - 3. Provide additional protection according to manufacturer instructions.

## 1.10 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

## 1.11 WARRANTY

- A. Section 017000 "Execution and Closeout Requirements" for requirements for warranties.

## PART 2 - PRODUCTS

### 2.1 PIPE PENETRATIONS

#### A. Performance and Design Criteria:

1. Firestop interruptions to fire-rated assemblies, materials, and components.
2. Firestopping: Provide certificate of compliance from authority having jurisdiction, indicating approval of materials used.

### 2.2 PIPE SLEEVES

#### A. All construction except new concrete walls:

1. Material: Schedule 40 galvanized steel conforming to ASTM A53.
2. 2-inch minimum circumference water stop welded to exterior sleeve at midpoint
3. Ends cut and ground to be:
  - a. Flush with ground.
  - b. Flush with ceiling.
  - c. 2 inches above finished floors.
  - d. Sealed with caulking.
  - e. Sized as required.

#### B. New concrete walls with pipes up to 20 inches in diameter:

1. Material: non-metallic High-Density Polyethylene Sleeves (HDPE)
2. Integral hollow molded water stops
  - a. 4 inches larger than the outside diameter of the sleeve.
3. End caps for forming and reinforcing ribs.
4. Domestically manufactured by:
  - a. Century-Line as manufactured by Pipeline Seal & Insulator, Inc., Houston, TX, or equal.

#### C. External wall penetrations:

1. 36 -in diameter and less may be made by means of a ductile iron sleeve capable of being bolted directly to the formwork.
2. Seal of the annular space between the carrier pipe and the sleeve made by means of a confined rubber gasket and be capable of withstanding 350 psi.:
3. Sleeve to have an integrally cast waterstop of 1/2-inch minimum thickness, 2-1/2-inch minimum height.
4. Manufacturers: Omni-Sleeve, Malden, MA or equal.

## 2.3 WALL CASTINGS

- A. Ductile iron conforming to ANSI/AWWA A21.51/C151, thickness Class 53.
- B. Diameter as required.
- C. Flanges and/or mechanical joint bells drilled and tapped for studs where flush with the wall.
- D. Castings provided with a 2-in minimum circumferential flange/waterstop integrally cast with or welded to the casting.
- E. Located as follows:
  - 1. for castings set flush with walls: located at the center of the overall length of the casting,
  - 2. for castings which extend through wall: located within the middle third of the wall.

## 2.4 SEALING MATERIALS

- A. Mechanical seals:
  - 1. Of rubber links shaped to continuously fill the annular space between the pipe and the wall opening or sleeve.
  - 2. Link pressure plates molded of glass reinforced nylon:
    - a. colored throughout elastomer,
    - b. permanent identification of the size and manufacturer's name molded into the pressure plate and sealing element.
  - 3. Hardware:
    - a. Mild steel with a 60,000 psi minimum tensile strength
    - b. 2-part Zinc Dichromate coating per ASTM B-633
    - c. Organic Coating, tested in accordance with ASTM B-117 to pass a 1,500-hour salt spray test.
    - d. Use Type 316 Stainless Steel hardware:
      - 1) in chemical areas
      - 2) for submerged service
      - 3) for penetrations in tanks containing sludge or wastewater.
  - 4. Completed sealing system:
    - a. Duty pressure rated for 20 psig differential pressure.
    - b. EPDM for all services except fire rated assemblies
      - 1) fire rated seals use silicone link material.
    - c. Manufacturer: PSI-Thunderline/ Link-Seal as manufactured by Pipeline Seal & Insulator, Inc., Houston, TX, or pre-approved equal.



B. Sealant:

1. A two-part foamed silicone elastomer manufactured by:
  - a. Dow Corning Co., Product No. 3-6548 silicone R.T.V.
  - b. 3M brand fire barrier products caulk C.P. 25 and 3M brand moldable putty MP+;
  - c. Flame-Safe fire stop systems FS-900 by Rectorseal.
2. Sealant bead configuration, depth and width in accordance with manufacturer's recommendations.

2.5 MISCELLANEOUS MATERIALS

A. Bonding compound:

1. Sikadur Hi-Mod epoxy by Sika Corp.
2. Euco 452 by Euclid Chemical Corp.; Master Builders Company.
3. Equal.

B. Non-shrink grout:

1. Masterflow 713 by Master Builders Co.;
2. Euco NS by Euclid Chemical Co.;
3. Five Star Grout by U.S. Grout Corp.
4. or equal.

2.6 FLEXIBLE CONNECTIONS

A. Manufacturers:

1. For pressure pipe applications and applications with steel and copper piping: Flexicraft Industries, Chicago, IL; Hyspan Precision Products, Inc.; Metraflex Company, Chicago, IL; Victaulic Company, Easton, PA or equal.
2. For non-pressurized applications involving plastic, clay, asbestos cement, or cast iron applications: Fernco or equal.

B. Copper Piping:

1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 125 psig WSP at 200 degrees F
4. Joints: Threaded with union
5. Maximum Offset: 1 inch on each side of installed center line.

C. Non-Pressurized Piping (Plastic, Clay, Asbestos Cement, Cast Iron utilized under 4.3 psig)

1. Flexible couplings: in accordance with ASTM D 5926, C1173 and CSA B602.
2. Couplings: rubberized PVC and be attached with the use of adjustable stainless steel clamps.

## 2.7 EXPANSION JOINTS

### A. Manufacturers:

1. Flexicraft Industries, Chicago, IL; Hyspan Precision Products, Inc.; Metraflex Company, Chicago, IL; Victaulic Company, Easton, PA or equal.

### B. Performance and Design Criteria:

1. Bellow Design: According to Section C of EJMA Standards.
2. Rubber Spool Design

### C. Stainless-Steel Bellows Type:

1. Pressure Rating: 125 psig WSP at 250 degrees F
2. Maximum Compression: 1-3/4 inches.
3. Maximum Extension: 1/4 inch.
4. Joint: Flanged
5. Application: Steel piping 3 inches and smaller.

### D. Single Sphere Flexible Compensators:

1. Body: NBR
2. Working Pressure: 150 psig
3. Maximum Temperature: 200 degrees F
4. Maximum Compression: 1 inch
5. Maximum Elongation: 7/8 inch
6. Maximum Offset: 1/2 inch
7. Maximum Angular Movement: 15 degrees.
8. Joint: stainless steel flanges
9. Accessories: stainless steel control rods
10. Application: Steel piping 2 inches and larger.

### E. Two-Ply Bronze Bellows Type:

1. Description: Bronze with anti-torque device, limit stops, and internal guides.
2. Pressure Rating: 125 psig WSP at 250 degrees F
3. Maximum Compression: 1-3/4 inches
4. Maximum Extension: 1/4 inch
5. Application: Copper piping.

### F. Copper with Packed Sliding Sleeve:

1. Maximum Temperature: 250 degrees F.
2. Joints: Threaded with unions
3. Application: Copper or steel piping 2 inches and larger.

### G. Single or double Arch Rubber Spool Type:

1. Spool: Nitrile.
2. Backing Rings: 300 Series Stainless Steel

3. Working Pressure: 150 psig.
4. Maximum Temperature: 200 degrees F.
5. Maximum Compression per arch: 3/4 inch
6. Maximum Elongation per arch: 5/8 inch
7. Maximum Offset per arch: 1/2 inch
8. Maximum Angular Movement per arch: 15 degrees.
9. Joint: Full-faced, Drilled to 150 # Standard, integral to body, with Backing Rings.
10. Accessories: Stainless Steel Control rods, Filled Arches.
11. Application: Piping 1 inch and larger.

## 2.8 SLEEVE-TYPE COUPLINGS

### A. Manufacturers:

1. GE Oil & Gas (Dresser); Xylem (Smith-Blair) or equal.

### B. Description:

1. Comply with AWWA C213, C219.
2. Middle Ring: Stainless Steel.
3. Followers: Stainless Steel.
4. Gaskets:
  - a. Material: Buna-N .
  - b. Comply with ASTM D2000.
5. Bolts: 316 Stainless Steel.

### C. Finishes:

1. Factory fusion bonded epoxy coated.

## 2.9 INSULATION

- A. As specified in Section 404213 "Process Piping Insulation."

## 2.10 FINISHES

- A. Prepare piping appurtenances for field finishes as specified in Section 099000 "Painting and Coating."

## 2.11 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
  1. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field dimensions are as indicated on Shop Drawings.
- B. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.
- C. Verify that openings are ready to receive sleeves and firestopping.
- D. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 inches from pipe ends.
- E. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

- A. Cleaning: Thoroughly clean end connections before installation.
- B. Close pipe and equipment openings with caps or plugs during installation.
- C. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

- A. According to ASME B31.3 or ASME B31.9
- B. Coating: Finish piping appurtenances as specified in Section 099000 "Painting and Coating" for service conditions.
- C. Pipe Penetrations:
  1. Flashing:
    - a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
    - b. Flash floor drains with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
    - c. Fasten flashing to drain clamp device.

2. Sleeves:

- a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
- b. Set sleeves in position in forms and provide reinforcement around sleeves.
- c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
- d. Extend sleeves through floors 1 inch above finished floor level and calk sleeves.
- e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with firestopping insulation and calk airtight.
- f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
- g. Install stainless-steel escutcheons at finished surfaces.

D. Firestopping:

1. Placement: Place intumescent coating in sufficient coats to achieve rating required.
2. Remove dam material after firestopping material has cured
3. Fire-Rated Surfaces:
  - a. Seal opening at floor, wall, partition, ceiling and roof as applicable.
  - b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
  - c. Size sleeve, allowing minimum of 1 inch void between sleeve and building element.
  - d. Pack void with backing material.
  - e. Seal ends of sleeve with UL-listed, fire-resistive silicone compound to meet fire rating of structure penetrated.
4. Non-rated Surfaces:
  - a. Seal opening through non-fire-rated wall, partition, floor, ceiling and roof as applicable.
  - b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
  - c. Size sleeve to allow minimum of 1 inch void between sleeve and building element.
  - d. Install type of firestopping material recommended by manufacturer.
  - e. Occupied Spaces:
    - 1) Install escutcheons or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
    - 2) Occupied spaces include rooms with finished ceilings and rooms where penetration occurs below finished ceiling.
  - f. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
  - g. Interior Partitions:
    - 1) Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

- E. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on Drawings.
- F. Expansion Joints:
  - 1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Drawings.
  - 2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.
- G. Air Release and Vacuum Breakers: Provide vacuum breakers as indicated on Drawings
- H. Insulation: As indicated on Drawings.

### 3.4 FIELD QUALITY CONTROL

- A. Section 017000 "Execution and Closeout Requirements" for requirements for testing, adjusting, and balancing.
- B. After installation, inspect for proper supports and interferences.
- C. Repair damaged coatings with material equal to original coating.

### 3.5 CLEANING

- A. Section 017000 "Execution and Closeout Requirements" for requirements for cleaning.
- B. Keep equipment interior clean as installation progresses.

### 3.6 ATTACHMENTS

- A. Pipe Schedule:
  - 1. Ductile Iron:
    - a. Material No.: 11
    - b. Reference Standard: AWWA C115
    - c. Joints:
      - 1) Type: Mechanical
      - 2) AWWA C110 and C111.
    - d. Fittings:
      - 1) Material: Ductile iron
      - 2) AWWA C110.
    - e. Gaskets: Buna-N
    - f. Test Pressure: 200 psig.

2. Copper:
  - a. Material No.: 17
  - b. Type: Seamless
  - c. Reference Standard: ASTM B251
  - d. Joints: Brazed. Threaded with unions at valves and fittings
  - e. Fittings:
    - 1) Material: Wrought copper
    - 2) ASME B16.29.
  - f. Test Pressure: 200 psig.
3. PVC:
  - a. Material No.: 21
  - b. Reference Standard: ASTM D1785
  - c. Joints: Solvent weld
  - d. Fittings:
    - 1) Material: Cast iron
    - 2) AWWA C111.
  - e. Test Pressure: 125 psig

END OF SECTION 400506





## SECTION 400507 - HANGERS AND SUPPORTS FOR PROCESS PIPING

### 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.
- B. This specification requires Contractor to delegate pipe support design to a pipe support design engineer hired by the Contractor. Where the Drawings show support types and/or locations, they shall be analyzed for adequacy to support loads and stresses calculated by the pipe support designer, modified if required, installed generally where shown, and integrated with the pipe support system design provided by the Contractor.
- C. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for execution requirements for placement of concrete housekeeping pads specified by this Section.
  - 2. Section 099000 "Painting and Coating" for product and execution requirements for painting specified by this Section.
  - 3. Section 400506 "Couplings, Adapters, and Specials for Process Piping."
  - 4. Section 400519 "Ductile Iron Process Pipe."
  - 5. Section 400523 "Stainless Steel Process Pipe and Tubing."
  - 6. Section 404213 "Process Piping Insulation."
  - 7. Section 404113 "Process Piping Electrical Resistance Heat Tracing."

#### 1.2 COORDINATION

- A. Section 013100 "Project Management and Coordination" for requirements for coordination.
- B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

#### 1.3 PREINSTALLATION MEETINGS

- A. Section 013100 "Project Management and Coordination" for requirements for preinstallation meeting.
- B. Convene minimum two weeks prior to commencing Work of this Section.

#### 1.4 ACTION SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.

- B. Product Data: Submit manufacturer's catalog data including load capacity.
- C. Shop Drawings: Submit scaled piping layouts for each system. Indicate flow stream, pipe size(s) material(s), schedule(s), lining(s), critical dimensions between pipes, equipment and building features. Indicate by schedule pipe hanger/support type and locations. Provide detail of each type of hangers, supports, anchors, and guides.
- D. Delegated Design Submittals: Support System Design
  - 1. Engage the services of an independent registered professional engineer licensed in the State of Virginia ordinarily engaged in the business of pipe support systems analysis and design, to analyze system piping and service conditions, and to develop a detailed support system design, specific to the piping material, pipe joints, valves, and piping appurtenances proposed for use.
    - a. The proposed support system engineer shall have at least 5 years of experience in the analysis and design of similar systems, including the use of commercial and custom pipe supports and in the use of commercial pipe stress software programs.
    - b. Engineer pre-approved support system engineering groups include the following:
      - 1) J. Blanco Associates, Inc. Hawthorne, NJ
      - 2) Fenny Engineering Company, Venice, FL
      - 3) LCI Engineering, Ottawa, Ontario, Canada.
  - 2. The support system design shall include:
    - a. Criteria by piping system.
    - b. Summary of Contractor-selected related components including joints, class, valves, appurtenances, etc., and commercial supports and especially including pipe materials.
    - c. Dead weight and dynamic analysis, including system thermal effects and pressure thrusts. Computer-based software system equivalent to Bentley Systems AutoPIPE or SST Systems CAEPIPE.
      - 1) Present each system in an isometric graphic and show the resolved and resultant force and moment systems, as well as all recommended hangers, supports, anchors, restraints, and expansion/flexible joints.
    - d. Submit a support system design to the Engineer for review. The submittal needs to be stamped by a professional engineer registered in Virginia.
    - e. All aspects of the analysis and design to comply with the provisions of ANSI B31.3 and the referenced standards.
    - f. Coordinate support arrangements to eliminate interference with similar systems to be installed under HVAC, Plumbing, and Electrical; to account for structural expansion joints and to maintain access for both personnel and for the removal of equipment.
- E. Manufacturers' Instructions: Submit special procedures and assembly of components.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Welders' Certificate: Submit welders' certification of compliance with ASME Section IX, verifying qualification within previous 12 months.
- C. Qualifications Statements:
  - 1. Submit qualifications for manufacturer, fabricator, installer, and licensed professional.
  - 2. Submit manufacturer's approval of installer.

## 1.6 DEFINITIONS

- A. Ferrous Metal: Iron, steel, stainless steel, and alloys with iron as principal component.
- B. Wetted or submerged: Submerged, less than 1-foot above liquid surface, below top of channel or tank wall, under cover or slab of channel or tank, or in other damp locations.
- C. "Pipe" or "piping" shall mean all piping, piping system(s), hose, tube, fittings, joints, valves, and similar appurtenances.
- D. Supports: wherever the word "supports" or "pipe supports" are used, they shall mean pipe supports, hangers, structural connections, concrete inserts (if allowed), anchors, guides, bolts, expansion units, restraints and all restraint, hanging, supporting, allowing controlled expansion, or other means of attaching piping along with the necessary appurtenances.

## 1.7 DELIVERY, STORAGE AND HANDLING

- A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.
- B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.
- C. Finished metal surfaces not galvanized, that are not of stainless steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.

## 1.8 QUALITY ASSURANCE

- A. Perform Work according to applicable authority and AWS D1.1 for welding hanger and support attachments to building structure.
- B. Perform Work according to Arlington County standards.

## 1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years' experience.
- B. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' experience.
- C. Installer: Company specializing in performing Work of this Section with minimum three years' experience.
- D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the Commonwealth of Virginia.

## 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.
- C. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

## 1.11 EXISTING CONDITIONS

- A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

## 1.12 WARRANTY

- A. Section 017000 "Execution and Closeout Requirements" for requirements for warranties.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Support pipe and appurtenances connected to equipment to prevent any strain being imposed on the equipment. Comply with manufacturer's requirements regarding piping loads being or not being transmitted to their equipment. Submit certification stating that such requirements have been met.
- B. Support and secure all pipe and tubing in the intended position and alignment to prevent significant stresses in the pipe or tubing material, valves, fittings, and other pipe appurtenances. Design all supports to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as

equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Section 055000 "Metal Fabrications" and shall be furnished and installed under this Section.

- C. Contractor may propose minor adjustments to the piping arrangements in order to simplify the supports, or in order to resolve minor conflicts in the work. Such an adjustment might involve minor change to a pipe centerline elevation so that a single trapeze support may be used.
- D. Where flexible sleeve, split ring, vibration, or other couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc., shall be rigidly supported to prevent transfer of force systems to the equipment. Do not install fixed or restraining supports between a flexible coupling and the piece of equipment.
- E. Pipe supports:
  - 1. Shall not induce point loadings but shall distribute pipe loads evenly along the pipe circumference.
  - 2. Provide supports at changes in direction and elsewhere as shown in the Drawings or as specified herein.
  - 3. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Engineer.
  - 4. Provide pipe supports to minimize lateral forces through valves, both sides of flexible split ring type couplings and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
  - 5. Effects of thermal expansion and contraction of the pipe to be accounted for in the pipe support selection and installation.
- F. Insofar as is possible, floor supports shall be given preference. Where specifically indicated, concrete supports, as shown on the Drawings, may be used. Base elbow and base tees shall be supported on concrete pedestals.
- G. Restraints, flexible connections, expansion items, and related items as included in other specifications (especially individual pipe sections) and shown on the Drawings.

## 2.2 PERFORMANCE REQUIREMENTS/DESIGN CRITERIA

- A. All supports and appurtenances shall be standard products from approved manufacturers wherever possible, and shall be adequate to maintain the supported load in proper position under all operating conditions. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Note that different materials required, as specified in Part 2 MATERIALS, may require different figures or model numbers than those shown.
  - 1. The minimum working factor of safety for all items, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10 feet of water-filled pipe being supported and normal test pressures.
  - 2. Design for all loads using a safety factor of 5.
- B. All items shall be designed with strength and stiffness to support, restrain, and allow expansion of the respective pipes under the maximum combination of peak loading conditions to include

pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces.

- C. Support spacing shall be per ASME B31.1. Complete design details of the pipe system components shall be submitted for review and approval as specified in Part 1. No support shall be installed without approved support system Drawings.
- D. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.
- E.
- E. Seismic Design and restraint requirements, in accordance with the Structural Design criteria.

## 2.3 MATERIALS

- A. For support of metallic pipe:
  - 1. Submerged, buried, or within outdoor structures (vaults, etc.): Type 316 stainless steel (SS).
  - 2. Within chemical areas: Vinyl ester fiberglass reinforced plastic (FRP) for pipe size up to 2 inch, epoxy coated steel for 2-1/2 inches size and larger.
  - 3. Other locations: steel with galvanizing where noted, or if not otherwise noted, coating as required in Division 09 Finished Painting.
  - 4. Additional requirements (including dielectric insulation): see following paragraphs.
- B. For support of non-metallic pipe:
  - 1. Submerged, buried, or within vaults: Type 316 stainless steel or FRP.
  - 2. Within chemical areas: vinyl ester FRP.
  - 3. Other locations: steel with galvanizing where noted, or if not otherwise noted, coating as required in Division 09 Finished Painting; all with local stress protection shields.
  - 4. Additional requirements (including stress protection shields): see following paragraphs
- C. Wherever stainless steel is noted, it shall be Type 316 unless noted otherwise.

## 2.4 INSULATION

- A. See also Section 404213 "Process Piping Insulation."

## 2.5 SUPPORT AND RESTRAINT SYSTEMS

- A. Steel or Ductile Iron Piping
  - 1. Cast iron and ductile iron, steel, and stainless-steel piping shall be supported at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.
  - 2. Support spacing for ductile iron, steel, and stainless-steel piping 2-in and smaller diameter shall not exceed 5 feet.

## B. Copper Piping

1. Supports for copper pipe shall be copper plated or shall have a 1/16-inch plastic coating.
2. Support spacing for copper piping and tubing 2 inch and smaller diameter shall not exceed 5 feet and greater than 2 inch diameter shall not exceed 8 feet.
3. Where pipe supports come in contact with copper piping, provide protection from galvanic corrosion by: wrapping pipe with 1/16 inch thick neoprene sheet material and galvanized protection shield; isolators similar to Cooper B-Line B3195CT; or copper-plated or PVC-coated hangers and supports.

## C. Non-Metallic Piping

1. All uninsulated non-metallic piping such as PVC, CPVC, HDPE, PVDF, etc., shall be protected from local stress concentrations at each support point. Protection shall be provided by non-metallic protection shields or other method as approved by the Engineer.
  - a. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360-degree arc support is required, such as U-bolts, protection shields shall be provided for the entire pipe circumference. All U-bolts or clamps for non-metallic pipes shall be plastic coated.
  - b. Protection shields shall have an 18-gauge minimum thickness, not be less than 12 inches in length, and be securely fastened to pipe with Type 316 stainless steel straps not less than 1/2 inch wide.
2. Individually supported PVC pipes shall be supported as recommended by the pipe manufacturer except that support-spacing shall be manufacturers recommendation minus 2-ft. down to 5 ft spacing recommendation, then spacing shall be 3 feet.
3. Supports for horizontal multiple PVC plastic piping:
  - a. Shall be continuous wherever possible.
  - b. Multiple, suspended, horizontal plastic PVC pipe runs, where possible, shall be supported by ladder type cable trays such as: Husky Ladder Flange Out by MPHusky; or equal.
  - c. Rung spacing shall be 12 inches. Tray width shall be approximately 6 inch for single runs and 12 inches for double runs.
  - d. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners similar to: Globe, Series 600; Unistrut Pipe/Conduit Clamps and Hangers; or equal.
  - e. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers, and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

## D. Framing Support System

1. See Part 2 MATERIALS for materials of construction.
2. Beams: Size such that beam stress does not exceed 25000 psi and maximum deflection does not exceed 1/240 of span.

3. Column Members: Size in accordance with manufacturer's recommended method.
  4. Support Loads: Calculate using weight of pipes filled with water.
  5. Maximum Spans:
    - a. Steel and ductile iron pipe, 3-inch diameter and larger: 10 feetcenters, unless otherwise shown.
    - b. Other pipelines and special situations: Same as noted in previous paragraphs. Supplementary hangers and supports may be required.
- E. All vertical pipes shall be supported at each floor or at intervals of not more than 12 feet by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to ensure rigid construction. All vertical pipes passing through pipe sleeves shall be secured using a pipe collar.

## 2.6 ANCHOR BOLTS/SYSTEMS

- A. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear, and pullout loads imposed by loading and spacing on each particular support. **DO NOTE USE ADHESIVE ANCHOR BOLTS ON ANY PIPE SUPPORT HUNG FROM A ROOF OR CEILING**, unless specifically noted otherwise.
- B. All post-installed anchors in concrete shall have current published ICC-ES Evaluation Report indicating the anchor is approved for installation in cracked concrete.
- C. The latest edition of the following specification and recommended practices shall become part of this specification as if written herein. Wherever requirements conflict, the more stringent shall govern.
1. ACI 318, Appendix D.
  2. ACI 355.2, Mechanical Anchors "Qualification of Post-Installed Mechanical Anchors in Concrete"
  3. Anchor manufacturer's published installation requirements.
- D. Expansion anchors:
1. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1 inch behind the steel reinforcement.
  2. Manufacturers:
    - a. Power-Stud+ SD4 and Power-Stud+ SD6 by Powers Fasteners, Brewster, NY,
    - b. Kwik Bolt as manufactured by Hilti USA, Tulsa, Oklahoma; or
    - c. Wej-it by Wej-it Expansion Products, Inc., Broomfield, Colorado.
- E. Unless otherwise noted: use Type 304 stainless steel anchoring parts/bolts and hardware for non-submerged supports, Type 316 stainless steel for submerged anchors.
- F. Size of anchor bolts as designed by manufacturer, 1/2 inch minimum diameter, or as shown on the Drawings.



- G. Anchors to concrete in chemical areas shall be epoxy secured vinyl ester FRP all thread, insertion depth and size as required by the manufacturer for the design loads. Nuts, bolts and hardware shall all be vinyl ester FRP construction.

2.7 HANGER RODS

- A. Where use of steel is allowed, hanger rods shall be hot-rolled steel, machine-threaded, and, except for stainless steel, galvanized after fabrication. The strength of the rod shall be based on its root diameter.
  - 1. Hanger rods shall be attached to concrete structures using single or continuous concrete inserts by the named support manufacturers above. Where use of steel is allowed, inserts shall be malleable iron or steel with galvanized finish.
  - 2. Beam-clamps, C-clamps, or welded-beam attachments shall be used for attaching hanger rods to structural steel members.
- B. Minimum rod size for metallic rod hangers: (\* For pipe diameters less than 14 inch, if using pipe roller, use 2 hanger rods with minimum diameter noted below for pipe's diameter).

C.

D.	E. Nominal Pipe / Tube Diameter	F. Minimum Hanger Rod Diameter
G. 1	H. Less than 2-1/2 inch	1/4 inch*
I. 2	J. 3 to 8 inches	K. 1/2 inch
L. 3	M. 10 to 14 inches	3/4 inch*
N. 4	O. 16 to 20 inches	P. 2 at 1 inch
Q. 5	R. 24 inches	S. 2 at 1-1/4 inch
T. 6	U. 30 inches	V. 2 at 1-1/2 inch

2.8 SINGLE PIPE HANGERS

- A. Unless otherwise indicated, pipe hangers and supports shall be standard catalogued components, conforming to the requirements of MSS-41, 58, or 69 and shall be of the following type:
  - 1. Anvil International
  - 2. Equal models by: Carpenter & Patterson, Inc., Woburn, MA; Cooper B-Line; Gulf State Manufacturing; or Unistrut Northeast, Cambridge, Massachusetts.
- B. Single pipes shall be supported by hangers suspended by hanger rods from structural steel members, concrete ceilings, bottom of trapeze hangers, and wall-mounted steel angle brackets.

- C. Where pipes are near walls, beams, columns, etc., and located an excessive distance from ceilings or underside of beams, welded steel wall brackets similar to Carpenter and Patterson, Figure Nos. 68, 79, 84, or 139 shall be used for hanging pipe. Where single pipes rest on top of bracket pipe supports, attachments shall meet requirements as specified under multiple pipe hangers.

## 2.9 MULTIPLE PIPE HANGERS

- A. Suspended multiple pipes, running parallel in the same horizontal plane that are adjacent to each other, shall be suspended by trapeze type hangers or wall brackets. Where use of steel is allowed, trapeze hangers shall consist of galvanized structural steel channel supported from galvanized threaded rod or attached to concrete walls, columns, or structural steel support members. See previous paragraphs about multiple PVC pipe supports.
- B. Except as otherwise specified herein, pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs similar to:
  - 1. Anvil Fig. 175
  - 2. Cooper B-Line B3147A or B3147B.
  - 3. Where use of steel is allowed, material of construction shall be galvanized steel. Chair U bolts shall be tightened to allow freedom of movement for normal expansion and contraction except where pipe must be anchored to control direction of movement or act as a thrust anchor.

## 2.10 SINGLE PIPE SUPPORTS FROM BELOW

- A. Single pipes located in a horizontal plane close to the floor shall be Pedestal type: Schedule 40 pipe stanchion, saddle, and anchoring flange.
  - 1. Nonadjustable Saddle: MSS SP 58, Type 37 with U-Bolt
    - a. Anvil, Figure 259.
    - b. Cooper B-Line, Figure B3090.
  - 2. Adjustable Saddle: MSS SP 58, Type 38 without clamp
    - a. Anvil, Figure 264.
    - b. Cooper B-Line, Figure B3093.
- B. Pipes less than 3 inch in diameter
  - 1. Hold in position by supports fabricated from steel C channel, welded post base similar to Unistrut, Figure P2072A, where use of steel is allowed; and pipe clamps similar to Unistrut, Figures P1109 through 26.
  - 2. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected by horizontal member of sufficient load capacity to support pipe.
  - 3. Fasten supports to nearby walls or other structural member to provide horizontal rigidity.
  - 4. More than one pipe may be supported from a common fabricated support.

- C. Pipes 3 inch in diameter and larger
  - 1. Support by adjustable stanchions.
  - 2. Provide at least 4 inch adjustment
  - 3. Flange mount to floor.
- D. Use yoked saddles for piping whose centerline elevation is 18 inch or greater above the floor and for all exterior installations.
- E. Pipe roller type supports shall be used where required to accommodate thermal movement in conjunction with axial supports.

#### 2.11 WALL SUPPORTED SINGLE AND MULTIPLE PIPES

- A. Single or multiple pipes located adjacent to walls, columns, or other structural members shall be supported using welded steel wall brackets, where use of steel is allowed, as manufactured by Carpenter and Patterson, Figure No. 69, 84, or 139.
- B. Where noted, multiple pipes may be supported on C-channel with steel brackets similar to Unistrut pipe clamps; with pipe anchor chairs; or equal.
- C. Individual pipes, up to 8-inch diameter, where noted, may use MSS Type 8 pipe clamps as noted on the Drawings.
- D. Securely fasten all members to wall, column, etc., using double-expansion shields or other method as approved by the Engineer. Provide additional wall bearing plates as required.

#### 2.12 BASE ANCHOR SUPPORT

- A. Bend Support: Where pipes change direction from horizontal to vertical via a bend, install a welded or cast base bend support to carry the load. Fasten to the floor, pipe stanchion, or concrete pedestal using expansion anchors or other method as approved by the Engineer.
- B. Concrete Supports: Where indicated, securely fasten pipe bends to concrete supports with suitable metal bands as required and approved by the Engineer. Isolate piping from poured concrete with a neoprene insert.

#### 2.13 VERTICAL PIPE SUPPORTS

- A. Where vertical pipes are not supported by a Unistrut type system as specified, they shall be supported in one of the following methods.
  - 1. For pipes 1/4 to 2 inch in diameter,
    - a. Provide extension hanger ring with an extension rod and hanger flange.
    - b. The rod diameter shall be as recommended by the manufacturer for the type of pipe to be supported.

- c. Where use of steel is allowed, the hanger ring shall be steel- or PVC-clad depending on the supported pipe material of construction. The hanger ring shall be equal to Carpenter & Patterson, Figure Nos. 81.
    - d. Where use of steel is allowed, the anchor flange shall be galvanized malleable iron similar to Carpenter and Patterson, Figure No. 85.
  2. For pipes equal to or greater than 2 inch in diameter,
    - a. extended pipe clamps similar to Carpenter & Patterson, Figure No. 267 may be used.
    - b. Attach hanger to concrete structures using double expansion shields,
    - c. Attach hanger to metal support members using welding lugs similar to Carpenter & Patterson, Figure No. 114.
- B. Pipe supports shall be provided for closely spaced vertical piping systems required to provide a rigid installation. The interval of vertical support spacing shall be as specified, but in no case shall vertical interval exceed 12 feet. The support system shall consist of a framework suitably anchored to floors, ceilings, or roofs.
- C. Unless otherwise specified, shown, or specifically approved by the Engineer, vertical runs exceeding 12 feet shall be supported by base elbows/tees, clamps, brackets, wall rests, and pipe collars, all located as required to ensure a rigid installation.
- D. Pipe riser clamps, per MSS SP58, shall be used to support all vertical pipes extending through floor slabs. Where use of steel is allowed, riser clamps shall be galvanized steel manufactured by:
  1. Carpenter & Patterson, Figure No. 128.
  2. Anvil, Figure 261.
  3. Cooper B-Line, Figure B3373.
  4. Or equal.
- E. Copper-clad or PVC-coated clamps shall be used on copper pipes. Insulation shall be removed from insulated pipes prior to installing riser clamps. Insulation shall not be damaged by clamp installation.

## 2.14 SPECIAL SUPPORTS

- A. Frame work supports
  1. Vertical and horizontal supporting members shall be U-shaped channels similar to Unistrut, Series P1000. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps. See pipe clamp and strap requirements.
  2. For piping 3 inch and smaller, framework shall be as manufactured by:
    - a. the Unistrut Corporation;
    - b. Power-Strut (or Ackinstruct where fiberglass systems are specified);
    - c. Multi-Strut by Carpenter-Paterson
    - d. or equal.

3. For piping larger than 3 inch, the support frame shall be fabricated from structural stainless steel or steel shapes, depending upon the support location, and secured through the use of drop in, adhesive or expansion anchors.
  4. The assemblies shall be furnished complete with all nuts, bolts, and fittings required for a complete assembly including end caps for all Unistrut members.
  5. Electrical Conduit Support: Under Division 26.
  6. The design of each individual framing system shall be the responsibility of the Contractor. Submit shop drawings, and show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached. See also Article "Support and Restraint."
- B. Supports not otherwise described in this Section shall be fabricated or constructed from standard structural stainless steel or steel shapes in accordance with applicable provisions of Section 055000 "Metal Fabrications," or Unistrut-type frame; have anchor hardware similar to items previously specified herein; shall meet the minimum requirements listed below; and be subject to the approval of the Engineer.
- C. Additional Pipe Support Situations
1. Supporting Multiple Chemical and Related Piping:
    - a. Location: indicated on Drawings or otherwise required, especially adjacent to chemical pumps.
    - b. Use: framework support.
    - c. Materials: FRP, with proper local stress protection.

## 2.15 SHOP FACTORY FINISHING

- A. Prepare and prime metallic (except stainless steel) supports in accordance with Division 09.

## 2.16 ACCESSORIES

- A. Insulation Shield: Install on insulated non-steel piping. Oversize the rollers and supports, as required. Manufacturers:
1. Anvil, Figure 167;
  2. Cooper B-Line, Series B3151.
- B. Welding Insulation Saddle: Install on insulated metal pipe. Oversize the rollers and supports, as required. Manufacturers:
1. Anvil, Figure 160;
  2. Cooper B-Line, Series B3160
- C. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
1. Isolation pads to be neoprene, waffle type.

2. Manufacturers:
  - a. Mason Industries, Type W;
  - b. Korfund.

D. Dielectric Barrier

1. Install between carbon steel members and copper or stainless steel pipe.
2. Install between stainless steel supports and non-stainless steel ferrous metal piping.
3. All stainless steel piping shall be isolated from all ferrous materials, including galvanized steel by use of neoprene sheet material and protection shields.

- E. Electrical Isolation: Install 1/4 by 3 inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Section 013100 "Project Management and Coordination" for requirements for installation examination.
- B. Verify field dimensions as indicated on Drawings.

#### 3.2 INSTALLATION

- A. Obtain permission from Project Officer before using powder-actuated anchors.
- B. Obtain permission from Project Officer before drilling or cutting structural members.
- C. Inserts:
  1. Install inserts for placement in concrete forms. Before setting inserts, all drawings and figures shall be checked that have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.
  2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 in and larger.
  4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- D. Pipe Hangers and Supports:
  1. Install according to: ASME B31.3.
  2. Support horizontal piping as indicated on Drawings, depending upon pipe size.
  3. Install hangers with minimum 1/2 inch space between finished covering and adjacent Work.

4. Place hangers within 12 in of each horizontal elbow.
5. Use hangers with 1-1/2 in minimum vertical adjustment.
6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
7. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
9. Support riser piping independently of connected horizontal piping.
10. Provide sheet lead packing between hanger or support and piping.
11. Design hangers for pipe movement without disengagement of supported pipe.
12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
13. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
14. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
15. Use beam clamps where piping is to be suspended from building steel.
16. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
17. Use offset clamps where pipes are indicated as offset from wall surfaces.
18. Proceed with installation of piping and supports only after any building structural work has been completed and new concrete has reached its 28-day compressive strength.
19. The installation of pipe support systems shall not interfere with the operation of any overhead bridge cranes, monorails, access hatches, etc. No piping shall be supported from stairs, other pipes, ladders, and walkways unless authorized by the Engineer.
20. Repair mounting surfaces to original condition after attachments are made.
21. Brace horizontal pipe movements by both longitudinal and lateral sway bracing.
22. Where supports are required in areas to receive chemical resistant seamless flooring, install supports prior to application of flooring system.

E. Insulation:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.
2. Conform to Section 404213 "Process Piping Insulation."

F. Equipment Bases and Supports:

1. Provide housekeeping pads as detailed on Drawings.
2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.
3. Construct supports of steel members, formed steel channel, or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
4. Provide rigid anchors for pipes after vibration isolation components are installed. Comply with Section 400513 "Common Work Results for Process Piping."

G. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. Conform to Section 099000 "Painting and Coating."
3. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

### 3.3 FIELD QUALITY CONTROL

- A. All pipe support systems shall be tested after installation in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired, augmented or replaced to the satisfaction of the Engineer.
- B. After the work is installed, but before it is filled for start-up and testing, the Support System Design Engineer shall inspect the work and shall certify its complete adequacy. Each system shall be inspected and certified in the same way.
- C. Submit a report, including all field modifications and including all certificates.
  - 1. Insert state where project is located
  - 2. The report shall bear the stamp of a professional engineer registered in the Commonwealth of Virginia and shall be subject to the review of the Engineer.

### 3.4 ATTACHMENT SCHEDULE

- A. Pipe Hanger Spacing:
  - 1. Pipe Material: ABS.
    - a. Maximum Hanger Spacing: 4 feet
    - b. 3/8 inch
  - 2. Pipe Material: Aluminum.
    - a. Maximum Hanger Spacing: 10 feet
    - b. 1/2 inch
  - 3. Pipe Material: Cast iron.
    - a. Maximum Hanger Spacing: 5 feet
    - b. 5/8 inch
  - 4. Pipe Material: Cast Iron, with 10-foot length of pipe.
    - a. Maximum Hanger Spacing: 10 feet
    - b. 5/8 inch
  - 5. Pipe Material: CPVC.
    - a. Size: 1 inch and smaller.
    - b. Maximum Hanger Spacing: 3 feet
    - c. 1/2 inch
  - 6. Pipe Material: CPVC.
    - a. Size: 1-1/4 inches and larger.
    - b. Maximum Hanger Spacing: 4 feet
    - c. 1/2 inch



7. Pipe Material: Copper tube.
  - a. Size: 1-1/4 inches and smaller.
  - b. Maximum Hanger Spacing: 6 feet
  - c. 1/2 inch
8. Pipe Material: Copper tube.
  - a. Size: 1-1/2 inches and larger.
  - b. Maximum Hanger Spacing: 10 feet
  - c. 1/2 inch
9. Pipe Material: Fiberglass:
  - a. Maximum Hanger Spacing: 4 feet
  - b. 1/2 inch
10. Pipe Material: Glass.
  - a. Maximum Hanger Spacing: 8 feet
  - b. 1/2 inch
11. Pipe Material: Polybutylene.
  - a. Maximum Hanger Spacing: 2.7 feet
  - b. 3/8 inch
12. Pipe Material: Polypropylene.
  - a. Maximum Hanger Spacing: 4 feet
  - b. 3/8 inch
13. Pipe Material: PVC.
  - a. Maximum Hanger Spacing: 4 feet
  - b. 3/8 inch
14. Pipe Material: Steel.
  - a. Size: 3 inches and smaller.
  - b. Maximum Hanger Spacing: 12 feet
  - c. 1/2 inch
15. Pipe Material: Steel.
  - a. Size: 4 inches and larger.
  - b. Maximum Hanger Spacing: 12 feet
  - c. 5/8 inch

END OF SECTION 400507



## SECTION 400519 - DUCTILE IRON PROCESS PIPE

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

#### A. Section Includes:

1. Ductile-iron pipe.
2. Ductile-iron, malleable-iron, and cast-iron fittings.
3. Accessories.

#### B. Related Requirements:

1. Section 099000 "Painting and Coating" for product and execution requirements for painting specified by this Section.
2. Section 400506 "Couplings, Adapters, and Specials for Process Piping" for piping appurtenances.
3. Section 400507 "Hangers and Supports for Process Piping" for hangers, anchors, sleeves, and sealing of piping to adjacent structures.
4. Section 400551 "Common Requirements for Process Valves" for common product requirements for valves for placement by this Section.
5. Section 400551 "Process Valves."

### 1.3 COORDINATION

- A. Section 013100 "Project Management and Coordination" for requirements for coordination.
- B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

### 1.4 PREINSTALLATION MEETINGS

- A. Section 013100 "Project Management and Coordination" for requirements for preinstallation meeting.

### 1.5 SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.
- B. Product Data: Submit manufacturer information regarding pipe and fittings.

- C. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, and materials lists.
- D. Manufacturer's Certificate: Prior to shipment of pipe, submit a certified affidavit of compliance from the pipe manufacturer stating that the pipe fittings, gaskets, linings and exterior coating for this project have been manufactured and tested in accordance with AWWA and ASTM standards and requirements specified herein.
- E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizing methods and calculations used.
- F. Source Quality-Control Submittals: Indicate results of shop tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Qualifications Statements:
  - 1. Submit qualifications for manufacturer, installer, and licensed professional.
  - 2. Submit manufacturer's approval of installer.
- I. American Iron and Steel (AIS): Submit certification indicating compliance with AIS requirements.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Section 017000 "Execution and Closeout Requirements" for requirements for submittals.
- B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, and centerline elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

#### 1.7 QUALITY ASSURANCE

- A. Materials (including linings) in Contact with Potable Water: Certified according to NSF 61 and NSF 372.
- B. Hydrostatically test each length of ductile iron pipe at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Furnish certified test results in duplicate to the Engineer prior to time of shipment.
- C. Inspect and test by Manufacturer the ductile-iron pipe and fittings at the foundry as required by the AWWA C600, Hydrostatic Testing. Furnish in duplicate to the Engineer sworn certificates of such tests and their results prior to the shipment of the pipe.
- D. Pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the Owner, at the Owner's expense.

- E. Engineer will inspect the pipe and fittings after delivery. Products are subject to rejection at any time on account of failure to meet any of the specified requirements, even though accepted as satisfactory at the place of manufacture. Immediately mark pipe rejected after delivery and remove from the job site.
- F. Permanently mark pipe and fittings with the following information:
  - 1. Manufacturer name and trademark
  - 2. Manufacturing date.
  - 3. Size, type, class, or wall thickness.
  - 4. Production Standard (AWWA, ASTM, etc.).
- G. Perform Work according to State of Virginia and Arlington County standards.

## 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer.
- C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the Commonwealth of Virginia.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. Photograph and provide written documentation of damaged materials.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Coverall openings to prevent entrance of dirt, water, and debris.
  - 3. Protect piping and appurtenances by storing off ground
  - 4. Limit stacking height to manufacturers specified maximum
  - 5. Provide additional protection according to manufacturer instructions.

## 1.10 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 DUCTILE IRON PIPE AND FITTINGS

#### A. Piping:

1. Comply with AWWA C150.
2. Thickness Class 53 of AWWA C150
3. Ductile Iron pipe as manufactured by U.S. Pipe and Foundry Company, Inc.; American Cast Iron Pipe Company; all divisions of the McWane Company or an approved equal who is a member of the Ductile Iron Pipe Research Association (DIPRA).

#### B. Fittings:

1. Material: ANSI B16.1 Class 125, ductile iron
2. Mechanical Joints:
  - a. Comply with AWWA C110 and AWWA C111.
  - b. Glands: Ductile iron with asphaltic coating.
  - c. Push-on Joints: Comply with AWWA C111.
3. Restrained Joints: Comply with AWWA C111.
4. Flanged Fittings: Comply with ASME B16.1 Class 125.
  - a. Assembly bolts: square headed carbon steel machine bolts with hexagon nuts per ANSI B18.2. Threads conform to ANSI B1.1. Bolt length: 1/8" to 5/8" protrusion from nut after torquing.
  - b. Existing Steel flanges in conformance with AWWA C207, Class D, may be mated to iron valves, fittings, or other parts having either integral Class 125 iron flanges or screwed Class 125 companion flanges. When such construction is used, the raised face on mating flanges shall be removed.
5. Grooved joints: Comply with AWWA C606
  - a. Rigid couplings: Style 31 couplings as manufactured by Victaulic, Anvil International, or approved equal.
  - b. For direct connection of ductile pipe to steel pipe of IPS sizes: Victaulic Style 307 transition coupling with offsetting, angle-pattern, bolt pads.
  - c. Grooved end fittings for AWWA ductile iron pipe: Conform to ANSI A21.10/AWWA C110 for center-to-end dimensions and ANSI A21.10/AWWA C110 or AWWA C153 for wall thickness, with AWWA C606 grooved ends.
6. Sleeve type couplings: Dresser Style 38 or 138 as manufactured by Dresser Industries, or equivalent products of Smith-Blair, Romac Industries, Ford Meter Box Co or approved equal.
7. Flanged coupling adaptors: Smith-Blair Type 913, or equivalent products of Klamflex Pipe Couplings (PTY) LTD, Robar Industries LTD or approved equal.

C. Cement-Mortar Lining:

1. Comply with AWWA C104.
2. Thickness: Standard.
3. Wastewater applications:
  - a. Cement mortar lining and asphaltic seal coat in accordance with AWWA C104.

D. Exterior Coating:

1. Exposed Service: As specified in Section 099000 "Painting and Coating."
2. If required, coatings "hold-backs" to be provided at pipe and fitting ends for satisfactory installation for joint connections in the field.
3. Provide all necessary coating materials to perform field coating applications at joints compatible with or equal to the shop applied material.
4. Field repair of pipe with damaged coating shall receive prior approval of the Engineer. If, in the opinion of the Engineer coating damage is beyond repair, pipe to be replaced at the expense of the Contractor.
5. All flange bearing surfaces shall be uncoated.
6. Mechanically clean or brush blast all surfaces to have exterior coating applied to ductile iron surfaces. Chemical cleaning or wiping with solvent is not acceptable.

## 2.2 ACCESSORIES

A. Thermal Insulation:

1. As indicated on the Drawings.

B. Gaskets:

1. full face type SBR per AWWA C111 to provide positive sealing for the flanged ductile iron joints.
2. Thickness 1/8-in
3. NSF61 certified for potable water applications.

## 2.3 SOURCE QUALITY CONTROL

A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Project Officer Inspection:

1. Make completed piping components available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Project Officer at least seven days before inspection is allowed.

D. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017000 "Execution and Closeout Requirements" for requirements for installation examination.
- B. Verify that field dimensions are as indicated on Drawings.
- C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flange mate properly.

3.2 PREPARATION

- A. Section 017000 "Execution and Closeout Requirements" for requirements for installation preparation."
- B. Thoroughly clean pipe and fittings before installation.
- C. Surface Preparation:
  1. Clean surfaces to remove loose rust, mill scale, and other foreign substances by power wire brushing.
  2. Touch up shop-primed surfaces with primer as specified in Section 099000 "Painting and Coating."
  3. Solvent-clean surfaces that are not shop primed.

3.3 INSTALLATION

- A. Exposed Service Piping:
  1. According to ASME B31.3.
  2. In compliance with manufacturer's instructions.
  3. Run piping straight along alignment as indicated on Drawings, with minimum number of joints.
  4. Clean each length prior to installation.
  5. Support per Section 400507.
  6. Do not use equipment flanges for support; support pipe separately.



B. Fittings:

1. According to manufacturer instructions.
2. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
3. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer instructions.
4. Flanged joints to be made using gaskets, bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts to conform to the same ANSI Standard as the flanges.
5. Provide required upstream and downstream clearances from devices as indicated on Drawings.

C. Make taps to ductile iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.

D. Install piping with sufficient slopes for venting or draining liquids and condensate to low points.

E. Support exposed piping as specified in Section 400507 “Hangers and Supports for Process Piping.”

F. Provide expansion joints as specified in Section 400506 “Couplings, Adapters, and Specials for Process Piping”, and pipe guides as specified in Section 400507 “Hangers and Supports for Process Piping”, to compensate for pipe expansion due to temperature differences.

G. Dielectric Fittings: Provide between dissimilar metals.

H. Field Cuts: According to pipe manufacturer instructions. Cutting by abrasive saw only, leaving a smooth cut at right angles to the axis of the pipe. Damage to the lining repaired to the satisfaction of the Engineer. Seal Field cut ends approved epoxy coating in accordance with manufacturer's instructions.

I. Finish primed surfaces according to Section 099000 “Painting and Coating.”

3.4 TOLERANCES

A. Section 014000 “Quality Requirements” for requirements for tolerances.

B. Deflection at joints not to exceed that recommended by the pipe manufacturer.

C. Supply and install fittings, in addition to those shown on Drawings, in areas where conflict exists with existing facilities.

3.5 FIELD QUALITY CONTROL

A. Section 017000 “Execution and Closeout Requirements” for testing, adjusting, and balancing requirements.

B. Inspection:

1. Inspect for damage to pipe lining or coating and for other defects that may be detrimental as determined by Engineer.
2. Repair damaged piping or provide new, undamaged pipe at no additional cost to the project.
3. After installation, inspect for proper supports and interferences.
  - a. Perform field test for straightness on 10 percent of 4" to 10" pipes. If the test results reveal deviation exceeds the maximum limits specified in ASTM B1000, perform the test on all the 4" to 10" pipes.
  - b. All pieces which fail the field test specified herein or do not meet the maximum allowable pinhole requirement specified in ASTM B1000 to be replaced at no additional cost to the Owner.

C. Pressure Testing:

1. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater [150 percent of maximum operating design pressure].
2. Conduct hydrostatic test for minimum two hours.
3. Filling:
  - a. Fill section to be tested with water slowly and expel air from piping at high points.
  - b. Install corporation cocks at high points.
  - c. Close air vents and corporation cocks after air is expelled.
  - d. Raise pressure to specified test pressure.
4. Observe joints, fittings, and valves under test.
5. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage and retest.
6. Leakage:
  - a. Correct visible deficiencies and continue testing at same test pressure for additional one hours to determine leakage rate.
  - b. Maintain pressure within plus or minus 5 psi of test pressure.
  - c. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
  - d. Compute maximum allowable leakage by following formula:
    - 1)  $L = SD \times \sqrt{P}/C$ .
    - 2) L = testing allowance in gph.
    - 3) S = length of pipe tested in feet.
    - 4) D = nominal diameter of pipe in inches.
    - 5) P = average test pressure during hydrostatic test in psig.
    - 6) C = 148,000.
    - 7) If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
  - e. If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
  - f. Correct visible leaks regardless of quantity of leakage.

3.6 CLEANING

- A. Section 017000 “Execution and Closeout Requirements” specifies requirements for cleaning.
- B. Keep pipe interior clean as installation progresses.
- C. After installation, clean pipe interior of soil, grit, and other debris.

END OF SECTION 400519  
*(references follow)*

EXHIBIT A  
Use as a reference

LININGS AVAILABLE FOR DUCTILE PIPE

Description:	Maximum Service Temp. (Degree F): [1]	Common Use:	Thickness:
CEMENT MORTAR	With Sealcoat - 150 Degrees Without Sealcoat - 212 Degrees	Non-Septic Gravity Sewers Sanitary Sewer Force Mains	
PETROLEUM ASPHALT COATING	150 Degrees	Air	1 Mil

- [1] Maximum service temperatures listed are intended as general guidelines. For higher service temperatures, consult manufacturer for specific recommendations.
- [5] Maximum service temperature for polyethylene for acids and alkali waste depends on the specific acid or alkali waste and service condition(s). Consult manufacturer for recommendations for elevated temperature service.

END OF EXHIBIT A

**EXHIBIT B**

Use as a reference

**GASKET MATERIALS USED FOR DUCTILE IRON PIPE IN WATER AND SEWERAGE SERVICE**

Description:  Push-on:	Maximum. Service Temperature (Degree F): [1] [2]		Common Uses: [3]
	Mechanical Gaskets:	Joint Gaskets:	
SBR (Styrene Butadiene)	150 Degrees	120 Degrees	Fresh Water Salt Water Sanitary Sewage
EPDM (Ethylene Propylene Diene Monomer)	250 Degrees	225 Degrees	Fresh Water Salt Water Sanitary Sewage Hot Water
Nitrile (NBR) (Acrylonitrile Bu- tadiene)	150 Degrees	120 Degrees	Hydrocarbons Fats Oils Greases Chemicals
Neoprene (R) (CR) (Polychloro- prene)	200 Degrees	200 Degrees	Fresh Water Salt Water Sanitary Sewage
Viton (R); Fluorel (R) (FPM) [4] (Fluorocarbon)	300 Degrees	225 Degrees	Hydrocarbons Acids Petroleum Vegetable Oils

- [1] Maximum service temperatures listed are intended as general guidelines for ductile iron pipe gaskets. For service temperatures greater than those listed, consult manufacturers for specific recommendations.
- [2] Minimum service temperature is not usually a meaningful parameter for piping gaskets; however, low temperatures during pipeline installation may necessitate precautions. Consult manufacturer for pertinent recommendations.
- [3] Water, including sanitary sewage, with low levels of the listed contaminants.
- [4] Consult manufacturer for availability of FPM push-on gaskets.

**END OF EXHIBIT B**



## SECTION 400523 - STAINLESS STEEL PROCESS PIPE AND TUBING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Stainless-steel pipe and fittings.
- 2. Stainless-steel tube and fittings.
- 3. Accessories.

- B. Related Requirements:

- 1. Section 400506 "Couplings, Adaptors, and Specials for Process Piping" for pipe penetrations, restrained joints, flexible connections, expansion joints and loops, and sleeve-type couplings.
- 2. Section 400507 "Hangers and Supports for Process Piping" for hangers, anchors, sleeves, and sealing of piping to adjacent structures.
- 3. Section 400551 "Process Valves" for common product requirements for valves for placement by this Section.
- 4. Section 404213 "Process Piping Insulation."
- 5. Section 404113 "Process Piping Electrical Resistance Heat Tracing."

#### 1.3 COORDINATION

- A. Section 013100 "Project Management and Coordination" for requirements for coordination.
- B. Coordinate Work of this Section with piping and equipment connections as specified in other Sections .

#### 1.4 PREINSTALLATION MEETINGS

- A. Section 013100 "Project Management and Coordination" for requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

## 1.5 SUBMITTALS

- A. Section 013300 “Submittal Procedures” for requirements for submittals.
- B. Product Data: Submit manufacturer information on pipe materials, tube materials, and fittings.
- C. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, and materials lists. Not all dimensions will be checked by the Engineer, nor will detailed review be performed. Contractor shall be responsible for accurate dimensioning of piping systems.
- D. Proposed cleaning method, including pre-cleaning, post-weld cleaning, chemicals to be used, or mechanical descaling method and final cleaning/passivation/pickling. Include the method and schedule for drying the pipe so that it is ready for service as part of the proposed cleaning method. Include the name and qualifications of the firm that will be doing the cleaning. Include the name and qualifications of the independent firm that will be doing the inspection of cleaned pipe.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Welder Certificates: Submit welders' certification of compliance with ANSI B31.3, Paragraph 127.5, verifying qualification within previous 12 months.
- G. Source Quality-Control Submittals: Indicate results of shop and factory tests and inspections.
- H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- I. Qualifications Statements:
  - 1. Submit qualifications for manufacturer, installer, and licensed professional.
  - 2. Submit manufacturer's approval of installer.

## 1.6 CLOSEOUT SUBMITTALS

- A. Section 017300 “Execution” for requirements for submittals.
- B. Project Record Documents: Record actual locations of valves, fittings, and appurtenances.

## 1.7 QUALITY ASSURANCE

- A. Permanently mark each length of pipe with manufacturer's name or trademark, and compliance with standards.
- B. Furnish all stainless steel pipe and fittings by a single manufacturer, who has a minimum of 5 years continuous and current experience in the manufacture of the items to be furnished.
- C. Perform Work according to Commonwealth of Virginia and Arlington County standards as applicable.



## 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum five years experience.
- C. Welders: AWS or ASME qualified within previous 12 months for employed weld types.
- D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in Commonwealth of Virginia.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. Document and notify Engineer if product is damaged.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Protect piping and appurtenances by storing off ground.
  - 3. Provide additional protection according to manufacturer instructions.

## 1.10 AMBIENT CONDITIONS

- A. Section 015000 "Temporary Facilities and Controls" for requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions: Do not store or handle uninstalled lined pipes or fittings at temperatures below zero degrees F

## 1.11 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Piping shall be installed in those locations indicated and as required for the complete piping system.
- B. Provide stainless steel piping for the following systems and conditions:
  - 1. System:
    - a. Fluid: scum
    - b. Pressure: 100 psi
    - c. Temperature: 32 to 150° F

### 2.2 STAINLESS-STEEL PIPE AND FITTINGS

- A. Piping:
  - 1. Schedule:
    - a. 2 ½ inches and smaller: 40S
    - b. 3 inches and larger: 10S
  - 2. Grade: ASTM A312/A312M Type 316 annealed, pickled and passivated. Use Type 316L for welded joints..
  - 3. Dimensions: Comply with ASTM A312/A312M.
- B. Joints:
  - 1. Type:
    - a. Piping 1 ½ inches and larger: rolled groove or flanged at valves and equipment. Welded, cut grooved or threaded joints will not be permitted.
- C. Fittings:
  - 1. Type:
    - a. Piping 1 ½ to 3 Inches : rolled or flanged.
  - 2. Dimensions: Comply with ASTM A312/A312M.
  - 3. Threaded Fittings for 1 ½ inch and smaller:
    - a. Comply with ASME B16.11 and ASTM A182.
    - b. Grade: Type 316.
    - c. Threads: Comply with ASME B1.20.1.
  - 4. Butt-Welding Fittings:

- a. Comply with ASTM A403/A403M (less than 3 inches) and ASTM A774/A774M (3 inches or larger).
  - b. Grade: Type 316.
  - c. Class: CR; comply with ASME B16.9 and MSS SP 43.
  - d. No field welding will be permitted. All welding must be done at the factory.
5. Rolled or cut groove for split ring couplings
- a. Minimum schedule 40 for cut groove
6. Flanged Fittings:
- a. Type: Slip on.
  - b. Class: 300.
  - c. Comply with ASTM A182/A182M.
  - d. Grade: Type 316.
  - e. Facing and Drilling: Comply with ASME B16.5, with 1/16-inch raised face.
  - f. Backing Flanges:
    - 1) Material: Stainless steel.
    - 2) Class: 150.
    - 3) Comply with ASTM A351/A351M.
    - 4) Grade: Type 1/16.
    - 5) Type: Van stone.
    - 6) Drilling: Comply with ASME B16.5.
  - g. Bolting:
    - 1) Bolts: Comply with ASTM A320/A320M, Grade B8M; hex head.
    - 2) Nuts: ASTM A194, Grade 316; hex head.
7. Flanged Connections: Required to connect stainless-steel piping to fittings and equipment.

## 2.3 ACCESSORIES

### A. Pipe-Thread Tape:

1. Material: PTFE.
2. Comply with ASTM D3308.

### B. O-Ring Seals: Fluoro-elastomeric.

### C. Flange Gaskets:

1. Comply with ASME B16.5.
2. Nonmetallic Gaskets:
  - a. Material: Viton GF.
  - b. Comply with ASME B16.21.

3. Type:
  - a. Raised-Face Flanges: Flat ring.
  - b. Flat-Face Flanges: Full face.

## 2.4 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.
- C. Project Officer Inspection:
  1. Make completed piping components available for inspection at manufacturer's factory prior to packaging for shipment.
  2. Notify Owner at least fourteen days before inspection is allowed.
- D. Certificate of Compliance:
  1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
  2. Specified shop tests are not required for Work performed by approved manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017300 "Execution" and Section 017700 "Closeout Requirements" for requirements for installation examination.
- B. Verify that field dimensions are as indicated on Shop Drawings.
- C. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

### 3.2 PREPARATION

- A. Section 017000 "Execution and Closeout Requirements" for requirements for installation preparation.
- B. Ream pipe ends and remove burrs.
- C. Bevel plain-end pipe.
- D. Thoroughly clean pipe and fittings before installation.

- E. Flush all pipe with water or other approved fluid to remove all dirt, and foreign material. Remove all debris from the pipe, flushing the lowest segment outlet last to assure debris removal.

### 3.3 INSTALLATION

- A. Comply with ASME B31.3.
- B. Run piping straight along alignment as indicated on Shop Drawings, with minimum number of joints.
- C. Fittings:
  - 1. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
  - 2. Install according to manufacturer instructions.
  - 3. Bolting:
    - a. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight.
    - b. Use torque wrench to tighten bolts to manufacturer instructions.
- D. Provide required upstream and downstream clearances from devices as indicated on Shop Drawings.
- E. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.
- F. Support exposed piping as specified in Section 400507 - Hangers and Supports for Process Piping.
- G. Provide expansion joints as specified in Section 400506 - Couplings, Adaptors, and Specials for Process Piping, and pipe guides as specified in Section 400507 - Hangers and Supports for Process Piping, to compensate for pipe expansion due to temperature differences.
- H. Dielectric Fittings: Provide between dissimilar metals.
- I. Field Cuts: According to pipe manufacturer instructions.
- J. Field welding of stainless steel is not permitted.

### 3.4 TOLERANCES

- A. Section 014000 "Quality Requirements" for requirements for tolerances.
- B. Piping Laying Tolerance: 5/8.

### 3.5 FIELD QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for inspecting and testing.

B. Inspection:

1. Inspect for damage to piping or tubing that may be detrimental as determined by the Engineer.
2. Repair damaged piping, or provide new, undamaged pipe.
3. After installation, inspect for required supports and anchoring, interferences, and damage to pipe, tube, or fittings.

C. Pressure Testing:

1. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
2. Conduct hydrostatic test for minimum two hours.
3. Filling:
  - a. Fill section to be tested with water slowly and expel air from piping at high points.
  - b. Install corporation cocks at high points.
  - c. Close air vents and corporation cocks after air is expelled.
  - d. Raise pressure to specified test pressure.
4. Observe joints, fittings, and valves under test.
5. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage and retest.
6. Leakage:
  - a. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
  - b. Maintain pressure within plus or minus 5 psi of test pressure.
  - c. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
  - d. Compute maximum allowable leakage by following formula:
    - 1)  $L = SD \times \sqrt{P}/C$ .
    - 2) L = testing allowance, in gallons per hour.
    - 3) S = length of pipe tested, in feet.
    - 4) D = nominal diameter of pipe, in inches.
    - 5) P = average test pressure during hydrostatic test, in psig.
    - 6) C = 148,000.
    - 7) When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
  - e. If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
  - f. Correct visible leaks regardless of quantity of leakage.

## SECTION 400531 – THERMOPLASTIC PROCESS PIPE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. PVC pipe.
2. CPVC pipe.
3. Fittings.
4. Accessories for plastic piping.

- B. Related Requirements:

1. Section 400506 “Couplings, Adapters, and Specials for Process Piping” for pipe penetrations, restrained joints, flexible connections, expansion joints and loops, and sleeve-type couplings.
2. Section 400507 “Hangers and Supports for Process Piping” for hangers, anchors, sleeves, and sealing of piping to adjacent structures.
3. Section 400551 “Process Valves” for common product requirements for valves for placement by this Section.

#### 1.3 COORDINATION

- A. Section 013100 “Project Management and Coordination” for requirements for coordination.
- B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

#### 1.4 PREINSTALLATION MEETINGS

- A. Section 013100 “Project Management and Coordination” for requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

#### 1.5 SUBMITTALS

- A. Section 013300 “Submittal Procedures” for requirements for submittals.

- B. Product Data: Submit manufacturer's catalog information regarding pipe and fittings.
- C. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, materials lists, location of all fittings, valves, and in-line accessories.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizes and sizing methods.
- F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Qualifications Statements:
  - 1. Submit qualifications for manufacturer, installer, and licensed professional.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Section 017700 "Closeout Procedures" for requirements for submittals.
- B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, and centerline elevations.

#### 1.7 QUALITY ASSURANCE

- A. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.

#### 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection:
  - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
  - 2. Manufacturer's Packaging: Comply with ASTM D3892.
- C. Storage: Store materials according to manufacturer instructions.



D. Protection:

1. Protect materials from puncture, abrasion, moisture, dust, and UV by storing in clean, dry location remote from construction operations areas.
2. Protect piping and appurtenances by storing off ground.
3. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

- A. Section 015000 "Temporary Facilities and Controls" for requirements for ambient condition control facilities for product storage and installation.
- B. Minimum and Maximum Temperatures: Do not install pipe when temperature is below 40 degrees F or above 90 degrees F if pipe is exposed to direct sunlight.
- C. UV Protection: Provide pipe installed above ground or outside with UV protection.

1.11 EXISTING CONDITIONS

- A. Field Measurements:
  1. Verify field measurements prior to fabrication.
  2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PVC PIPE, TUBE, AND FITTINGS

- A. PVC Pipe and Fittings:
  1. Pipe and Fittings:
    - a. Comply with ASTM D1785, Class 12454.
    - b. Schedule: 40
    - c. Fittings: ASTM D2466, Schedule 40, socket

2.2 CPVC PIPE AND FITTINGS

- A. Description:
  1. Pipe:
    - a. Comply with ASTM F441
    - b. Schedule: 40
  2. Fittings:

- a. Flanges: Comply with ASME B16.5; rated for a maximum 150 psig working pressure.
  - b. Socket Type: Comply with ASTM F438, Schedule 40
  - c.
3. Joints: Socket welded
  4. Materials:
    - a. Comply with ASTM D1784.
    - b. Minimum Cell Classification: 23447.

## 2.3 ACCESSORIES

### A. PVC Piping:

1. Flange Bolting:
  - a. Hex-Head Bolts: Stainless steel; ASTM Grade 316 Stainless Steel.
  - b. Hex-Head Nuts: Stainless steel; ASTM Grade 316 Stainless Steel.
2. Flange Gaskets:
  - a. Type: Full faced.
  - b. Material: NBR.
  - c. Comply with ASME B16.21.
3. Push-On Joint Seals:
  - a. Material: NBR.
  - b. Comply with ASTM F477.
4. Solvent Cement:
  - a. Comply with ASTM D2564.
  - b. Formulated for use with sodium hypochlorite and other caustic solutions.

### B. CPVC Piping:

1. Flange Bolting:
  - a. Hex-Head Bolts: Stainless steel; ASTM F593 Grade 316stainless steel.
  - b. Hex-Head Nuts: Stainless steel; ASTM F594 Grade 316 stainless steel.
2. Flange Gaskets:
  - a. Type: Full faced.
  - b. Material: NBR.
  - c. Comply with ASME B16.21.
3. Solvent Cement:

- a. Comply with ASTM F493.
- b. Formulated for use with sodium hypochlorite and other caustic solutions.
- c. Primers: Manufactured by the solvent weld cement manufacturer.

## 2.4 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed pipe sections.
- C. Project Officer Inspection:
  1. Make completed pipe sections available for inspection at manufacturer's factory prior to packaging for shipment.
  2. Notify Project Officer at least seven days before inspection is allowed.
- D. Certificate of Compliance:
  1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
  2. Specified shop tests are not required for Work performed by approved manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017300 "Execution": Requirements for installation examination.
- B. Verify that field dimensions are as indicated on Drawings.
- C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flange mate properly.

### 3.2 PREPARATION

- A. Section 017300 "Execution": Requirements for installation preparation.
- B. Ream pipe ends, remove burrs , and bevel plain-end pipe.
- C. Thoroughly clean pipe and fittings before installation.
- D. Cleaning: Clean surfaces to remove foreign substances.

### 3.3 INSTALLATION

- A. Comply with ASME B31.3 and B31.9.

- B. Run piping straight along alignment as indicated on Drawings, with minimum number of joints.
  - C. Fittings:
    - 1. According to manufacturer instructions.
    - 2. Gaskets:
      - a. Clean seats thoroughly.
      - b. Wipe gaskets clean prior to installation.
    - 3. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer instructions.
  - D. Provide required upstream and downstream clearances from devices as indicated.
  - E. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.
  - F. Support exposed piping as specified in Section 400507 - Hangers and Supports for Process Piping.
  - G. Provide expansion joints as specified in Section 400506 - Couplings, Adapters, and Specials for Process Piping, and provide pipe guides as specified in Section 400507 - Hangers and Supports for Process Piping, to compensate for pipe expansion due to temperature differences.
  - H. Field Cuts: According to pipe manufacturer instructions.
  - I. Joining:
    - 1. Heat Joining: Comply with ASTM D2657.
      - a. Butt-fusion joints to be done by a factory-qualified joining technician as designated by the pipe manufacturer.
      - b. Field Samples: join two sample welds on each size of pipe to be installed using the same fusion welding equipment that will be used for completion of the entire work. These sample welds will be compared to the manufacturer's sample previously submitted in accordance with Part 1.
      - c. Pipe joints with beads in excess of 3/16-in will not be approved by the Engineer.
    - 2. Electrofusion: Comply with ASTM F1290.
    - 3. Primers and Cleaners: Comply with ASTM F402.
    - 4. PVC Solvent-Cemented Joints: Comply with ASTM D2855.
  - J. Insulation: As indicated on Drawings.
- 3.4 TOLERANCES
- A. Section 014000 "Quality Requirements" for requirements for tolerances.

### 3.5 FIELD QUALITY CONTROL

- A. Section 017300 “Execution” for requirements for testing, adjusting, and balancing.
- B. Inspection:
  - 1. Inspect for piping defects that may be detrimental as determined by the Engineer.
  - 2. Repair damaged piping, or provide new, undamaged pipe.
  - 3. After installation, inspect for proper supports and interferences.
- C. Pressure Testing:
  - 1. Test Pressure: Not less than 150 psig or 1.5 times the system’s working pressure, whichever is greater.
  - 2. Conduct hydrostatic test for minimum two hours.
  - 3. Filling:
    - a. Fill section to be tested with water slowly and expel air from piping at high points.
    - b. Install corporation cocks at high points.
    - c. Close air vents and corporation cocks after air is expelled.
    - d. Raise pressure to specified test pressure.
  - 4. Observe joints, fittings, and valves under test.
  - 5. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage and retest.
  - 6. Leakage:
    - a. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
    - b. Maintain pressure within plus or minus 5 psiof test pressure.
    - c. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
    - d. Correct visible leaks and repeat test to verify no leaks at the required test pressures.

### 3.6 CLEANING

- A. Sections 017300 “Execution” and 017700 “Closeout Procedures” for requirements for cleaning.
- B. Keep pipe interior clean as installation progresses.
- C. Clean pipe interior of soil, grit, shavings, and other debris after pipe installation.

END OF SECTION 400531



## SECTION 400551 - PROCESS VALVES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes:

1. Solenoid valves for process applications.
2. Weight-loaded pressure-relief valves.
3. Spring-loaded pressure-relief valves.
4. Hydrostatic pressure-relief valves.
5. Swing check valves 3 inches and larger.
6. Rubber-seated ball valves.
7. Thermoplastic Plastic ball valves.
8. Eccentric plug valves.
9. Knife Gate Valves.
10. Gate Valves (2-1/2 inch and smaller)
11. Gate Valves (30 inch and larger)

- B. Related Requirements:

1. Section 099000 "Painting and Coating" for coating and touchup of shop-primed surfaces with primer.
2. Section 400557 "Actuators for Process Valves and Gates."
3. Section 400507 "Hangers and Supports for Process Piping."
4. Section 400531 "Thermoplastic Process Pipe."
5. Section 404213 "Process Piping Insulation."
6. Section 400557 "Actuators for Process Valves and Gates."

#### 1.3 COORDINATION

- A. Coordinate Work of this Section with process piping Work as specified in other Sections and as indicated on Drawings.
- B. Note that solenoid valves may be shown on Electrical and/or Mechanical Drawings, or may only be specified, but if so specified or shown, shall be provided. Solenoid valves located in hazardous classified areas shall be provided with electrical enclosures which satisfy the electrical classification as specified or shown on the electrical drawings.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Data: Submit manufacturer information, indicating materials of construction, wiring diagrams, and compliance with indicated standards.
  - 1. Submit manufacturer information for actuator with model number and size indicated.
  - 2. Submit valve cavitation limits.
  - 3. Submit actuator Shop Drawings with valve and gate submittal.
- C. Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, control system schematics with all external interfaces on assembly drawings.
- D. Certification of Valves Larger Than 12 Inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.
- E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.
- F. Valve-Labeling Schedule: Indicate valve locations and nametag text.
- G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- H. Manufacturer Instructions: Submit special procedures and setting dimensions.
- I. Qualifications Statement:
  - 1. Submit qualifications for manufacturer.
- J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- K. Source Quality-Control Submittals: Indicate results of factory tests and inspections and provide required certifications, except solenoid valves.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- B. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- C. Coordination Drawings: drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.
- E. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.



A. Qualifications Statement:

1. Submit qualifications for manufacturer and licensed professional.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping, valves, actuators and other appurtenances, connections, and centerline elevations.

B. Maintenance Data: For each valve to include in maintenance manuals.

C. Operation and Maintenance Data: For to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Maintain clearances as indicated on Drawings.

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

D. Perform Work according to plant standards.

E. Maintain two copies of each standard affecting Work of this Section on Site.

F. Ball Valves: Test valves in accordance with AWWA C504, API 598, MSS SP61 as applicable for types listed herein.

G. Plug Valves: Test valves in accordance with AWWA C517

H. Knife Gate Valves: Test valves in accordance with AWWA C520.

I. Gate Valves (3-inch and greater): Test valves in accordance with AWWA C500.

J. Valve Actuators in NEC Class I, Group C and D, Division 1 or 2 Hazardous Locations: Comply with NFPA 70. Where wet or submergence conditions are to be met, NEMA standard 4X and if installed in areas with submergence exceeding 30 minutes, NEMA 6P or IP68

K. Valve actuators of the same type to be the product of one manufacturer, coordinate this requirement with actuated valves included in the scope of vendor furnished equipment.

L. Mate valves to actuators at manufacturers or integrators facility. Fully test assembled product and certify ready for installation prior to shipment to the job site. Only in special cases for extremely large assemblies where installation requires disassembly may the actuator be mounted to the valve in the field.

- M. Manufacturer Qualifications: .
  - 1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years' documented experience.
- N. Installer Qualifications: Company specializing in performing Work of this Section with minimum three years' documented experience.
- O. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- P. Obtain Manufacturer's Certificate of Compliance for Specified valves and valve assemblies.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Protect valves and appurtenances by storing off ground.
  - 3. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
  - 4. Provide additional protection according to manufacturer instructions.
  - 5. Provide additional protection according to manufacturer instructions.

#### 1.9 FIELD CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

#### 1.10 WARRANTY

- A. Furnish three-year manufacturer's warranty for solenoids, ball valves, and swing check valves.
- B. Furnish five-year manufacturer's warranty for pressure-relief valves, plug valves, knife gate valves, and gate valves.
- C. Furnish five-year manufacturer's warranty for manual or electric-motor actuators.
- D. Manufacturer's Warranty: Manufacturer and Installer agrees to repair or replace and valve that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: five year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 VALVES, GENERAL

- A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.
- B. Valve Ends: Compatible with adjacent piping system.
- C. Operation:
  1. Open by turning counterclockwise; close by turning clockwise.
  2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.
- D. Valve Marking and Labeling:
  1. Marking: Comply with MSS SP-25.
- E. Valve Construction:
  1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
  2. Bonnets:
    - a. Clamped, screwed, or flanged to body and of same material and pressure rating as body.
    - b. Furnish glands, packing nuts, or yokes as specified in valve Sections.
  3. Stems and Stem Guides:
    - a. Materials and Seals: As specified in valve Sections.
    - b. Bronze Valve Stems: According to ASTM B62.
    - c. Space stem guides 10 feet.c.
    - d. Submerged Stem Guides: Type 304 stainless steel.
  4. Nuts and Bolts: As specified in Section 055000 - Metal Fabrications.

### 2.2 VALVE ACTUATORS

- A. Description: Actuators to move the valve or gate from the full open to full closed position and back again and hold the valve at any position part of the way between full open and closed. Unless otherwise noted, provide all valves with manual actuators that utilize an operating wheel, handle or lever. Where noted, furnish the appropriate accessories to operate valves or gates provided with 2-inch operating nuts. Furnish gear manual actuators where manual operator effort is greater than 40 ft-lb rim pull. Furnish power actuators where noted for remote operation of the valve.

- B. Provide actuators in accordance with the valve schedule included on the Drawings.
- C. Provide actuators with position indicators for shutoff valves 4 inches and larger.
- D. Comply with AWWA C542.
- E. Provide chain actuators for shutoff valves mounted 6 feet above operating floor level.
- F. Provide gear and power actuators with position indicators.
- G. Floor Stands with Actuators
  - 1. For rising stem valve or gate stem applications, provide extension stems and guides with a cast iron floor stand 36-inch high, bolted to concrete floor or heavy reinforced wall bracket.
  - 2. Mount a manual handwheel on top of floor stand. Where manual effort is greater than 40 ft-lb rim pull, provide geared actuator with a handwheel or crank.
  - 3. Handwheel casting to include the word "OPEN" and an arrow indicating the direction of operation.
  - 4. Supply fracture-resistant clear polycarbonate stem covers. Top to be closed and have indicator markings to indicate valve/gate position.
- H. Gear-Assisted Manual Actuators:
  - 1. Provide totally enclosed gears.
  - 2. Maximum Operating Force: 60 lbf.
  - 3. Bearings: Permanently lubricated bronze.
  - 4. Packing: Accessible for adjustment without requiring removal of actuator from valve.
- I. Chain Actuator:
  - 1. Description:
    - a. Chain actuators for shutoff valves 3-in diameter or larger mounted 6 feet and greater above operating floor level.
    - b. Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above operating floor level.
  - 2. Chain Wheels: Sprocket-rim type.
  - 3. Furnish chain storage if chains may interfere with pedestrian traffic.
- J. Valve Actuators in NEC Class I, Group D, Division 1 or 2 Hazardous Locations: UL approved.

## 2.3 SOLENOID VALVES

- A. Manufacturers:
  - 1. Solenoid valves less than 2": Red Hat Valve by ASCO Valve, similar by Circle Seal Controls-Atkomatic Valve Co.
  - 2. Solenoid valves 2" or greater: Type A by Magnatrol Valve Corp
  - 3. Substitutions: not permitted.

B. Description:

1. Type: As indicated on Drawings
2. Minimum Working Pressure: 150psig at 50 degrees F.
3. Minimum Working Pressure Differential: :0 psig
4. Maximum Fluid Temperature: 200degrees F
5. Coil: Continuous duty.
6. Operation: as indicated on Drawings. Enclosures: as indicated on Drawings.
7. Electrical Characteristics: As indicated on Drawings.
8. End Connections: to match associated piping system.
9. Conduit Connection: to match associated piping system.
10. Valves 2” in size or larger shall include a manual override actuated by a handle-levered plunger mounted to the bottom of the valve body. These valves must be mounted in a horizontal run of piping, with the solenoid up in the vertical position.

C. Materials:

1. Body: Brass.
2. Trim and Spring: Stainless steel with copper coil Class A encapsulated.
3. Seals: PTFE or as required for process material.

2.4 PRESSURE-RELIEF VALVES, SPRING LOADED– Tag Type PRV2

A. Manufacturers:

1. Asahi-America, Plast-O-Matic

B. Description:

Size: As indicated on Drawings

1. Spring opposed, angle-pattern design with adjustable relief pressure and locking nut.
2. Performance and Design Criteria:
  - a. Maximum Pressure Setting: TBD during shop drawing review.
  - b. Pressure Setting Available Range: 150 psig
3. Materials:
  - a. Body: Same material as pipeline in which valve is installed.
  - b. Trim: Type 316 stainless steel.
  - c. Spring: Elastomer-coated and isolated from process flow.
  - d. Seat: PTFE.
4. End Connection: solvent welded

## 2.5 PRESSURE-RELIEF VALVES, HYDROSTATIC– Tag Type PRV3

### A. Manufacturers:

1. Troy Valve (Penn-Troy Manufacturing, Inc.)

### B. Description:

1. Size: As shown on Drawings.
2. Materials:
  - a. Frame and Cover: Cast bronze, ASTM B584.
  - b. Hinge Pin: Type 304 stainless steel, ASTM A276.
  - c. Seat: Neoprene, ASTM D2000 or as required for service.
3. End Connection: Flanged, ASME B16.5.

### C. Accessories:

1. Cast-iron wall sleeve with integral strainer and waterstop.
2. Flange bolts and gasket.

## 2.6 IRON BODY SWING CHECK VALVES 4-INCH AND LARGER - Tag Type SCV1

### A. Manufacturers:

1. DeZurik or approved equal.
2. Substitutions: As specified in Section 016000 - Product Requirements

### B. Description:

1. Comply with AWWA C508.
2. Size: 4 inches and larger.
3. Type: Swing, metal disc, with hinge shaft extended from body, sealed with stuffing box, packing and gland. Furnish outside lever and control specified below.
4. Seat: metallic
5. Minimum Working Pressure: 175 psig4 to 12-inch diameter, 150 psig 14 to 30-inch diameter at 70 deg. F
6. Maximum Fluid Temperature: 200 deg. F
7. Disc controller:
  - a. adjustable weight
8. Mounting: Horizontal or vertical.
9. End Connections: ANSI 150lb

### C. Materials:

1. Body and Cover: Cast iron, ASTM A126.
2. Disc: Bronze, ASTM B62.
3. Seat: Field replaceable, Type 316 stainless steel.

4. Cover hardware: 316 stainless steel.
5. Chamber and Plunger: Bronze, ASTM B62.
6. Hinge Shaft and Key: Stainless steel.
7. Hinge Shaft Gland: A582 Type 416 Stainless Steel
8. Packing and O-Ring: As required for service.
9. Grease Fittings: 316 stainless steel
10. Rubber Components: Viton for Scum systems and Buna-N for all other systems described herein.
11. Connecting Hardware: Type 316 stainless steel.

D. Controls

1. Position switches: lever type, NEMA 7 enclosure, SPST, 120V DC, 6A, Square D Type 9007CR or approved equal.
2. Bracket and hardware: Type 316 stainless steel.

2.7 SWING CHECK VALVES 3-INCH AND SMALLER: Tag Type SCV3

A. Manufacturer:

1. Solder or thread end Hammond 1B-940, or Jenkins Figure 996.
2. Flanged end Hammond 1R-1124 or Jenkins Figure 587J.

B. Description:

1. Comply with MSS SP-71, 80.

2.8 AWWA RUBBER-SEATED BALL VALVES - Tag Type BV1

A. Manufacturers:

1. Pratt, Val-Matic.

B. 4 Inchesthrough 60 Inches

1. AWWA C507, Class 150.
2. Minimum Working Pressure: 200 psig at 350 deg. F.
3. Design minimum fluid velocity: 35 feet per second.
4. Maximum Process Fluid Temperature: 200 degree F
5. Body:
  - a. Material: Cast iron, ASTM A126.
  - b. Seats: Rubber or as required.
6. Ball:
  - a. Material: Cast iron, ASTM A126.
  - b. Surfacing: Stainless steel.
7. Bearing Seal, O-Rings, and Packing: Buna-N or as required.

8. Shaft and Attachment Pins: Type 316 stainless steel.
9. Bearings: PTFE-lined with fiberglass backing.
10. Shaft Seals: Self-lubricating and self-adjusting.
11. Connecting Hardware: Type 316 stainless steel.
12. End Connections:
  - a. Flanged: Comply with ASME B16
13. Operator: per Valve Schedule.

## 2.9 TWO-PIECE IRON BODY BALL VALVES- Tag Type BV2

### A. Manufacturers:

1. Sureflow 125BV1S, American Valve Series 4000

### B. Description:

1. Comply with MSS SP 72, ANSI B16.10, AWWA C507-Proof of Design.
2. Minimum Working Pressure: 200 psi WOG
3. Maximum Temperature Rating: 353 Deg. F.
4. Body: two piece, bolted
5. Ball: full port, floating design.
6. Seats: Resilient and replaceable
7. Stem: blow out proof, O ring sealed.
8. End Connections: Class 125 Flange, Flat Faced
9. Stem Seals/Packing:
  - a. Multiple Chevron Rings
  - b. mechanically retained

### C. Actuator:

1. Per valve schedule.
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

### D. Materials:

1. Body: Cast iron ASTM A126, Class B
2. Ball: Cast Iron, PFA Fused.
3. Seats: PTFE or as required.
4. Seat Ring: RPTFE/Graphite
5. Stem: 316 SS
6. Stem Seal/Packing: PTFE or as required.

## 2.10 COMPOSITE BODY BALL VALVES - Tag Type BV7

### A. Manufacturers:



1. Nil-Cor Series 300, 310, 410, 500, 610 or PureFlex Series 400, 405, 450, 455 as required by the process fluid.
2. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:

1. Comply with ANSI B16.5, ISO 5211
2. Minimum Working Pressure: 200 psi WOG
3. Maximum Temperature Rating: 400 Deg. F.
4. Body: unibody
5. Ball: full port, floating, self-adjusting. Drilled with relief hole.
6. Seats: Resilient and replaceable
7. Stem: blow out proof, O ring sealed.
8. End Connections: ANSI Class 150 Flange
9. Stem Seals/Packing: live loaded, high cycle, multiple chevron ring

C. Actuator:

1. Per valve schedule.

D. Materials:

1. Body: Glass or graphite fiber reinforced vinyl ester, polysulfone or epoxy suitable for intended service.
2. Ball: Glass or carbon graphite reinforced vinyl ester, polysulfone or epoxy, micropolished OD.
3. Seats/body seals: Reinforced PTFE, FEP encapsulated Viton seat energizers.
4. Seat Ring: RPTFE/Graphite
5. Stem: Hastelloy C276 encapsulated with Carbon graphite reinforced vinyl ester or epoxy
6. Gland Assembly: Hastelloy C276, live loaded with Belleville washers
7. Stem Seal/Packing: [PTFE, Chevron type]
8. Stem Bearings: Graphite/PTFE

## 2.11 THERMOPLASTIC BALL VALVES

A. Manufacturers:

1. Hayward.

B. Description:

1. Minimum Working Pressure: 200 psig at 200 deg. F.
2. Maximum Process Fluid Temperature: 200deg. F.
3. Ports: Full size.
4. End Connections:
  - a. Flanged: Comply with ASME B16.
  - b. Union

C. Operator

1. Body and Ball: PVC, ASTM D1784.
2. Seats: PTFE.

D. Operator: Electric

1. Electric Operators for Plastic Valves 2-1/2-in Diameter and Less: 115Volt, single phase, 60 Hz, reversing motor with integral thermal overload protection with automatic reset, 100 percent duty cycle, 2 single pole double throw open and close limit switches, deswitchable manual override, mechanical visual position indicator, permanently lubricated gear train, stainless steel output shaft, and contacts for remote open/close status.
2. Enclosure: Rated NEMA 7.

2.12 ECCENTRIC PLUG VALVES – Tag Type PV1

A. Manufacturers:

1. DeZurik; M&H Valve

B. Description:

1. Type:
  - a. Offset disc type
  - b. Non-lubricated
  - c. Serviceable (able to be repacked) under full line pressure
  - d. Eccentric.
  - e. Capable of sealing in both directions at the rated pressure
  - f. unobstructed flow path when open
  - g. Drop tight shut-off to the full valve rating with pressure on either side of the plug.
2. Body:
  - a. 30,000-psi tensile strength
  - b. Top entry, bolted bonnet
  - c. Body shall be cast with integral piping connections
3. Plug:
  - a. To be removable without removing the valve from the line.
  - b. To have an integral upper and lower shaft:
    - 1) seals on the upper and lower journals to prevent entrance of solids into the journals.
  - c. one piece for all valves.

4. Bearings:
    - a. Permanently lubricated
  5. Minimum Working Pressure: Per valve schedule.
    - a. At the above rated minimum working pressures, certified by the manufacturer as permitting zero leakage for a 5-minute duration with full pressure applied in either direction.
  6. Ports:
    - a. Configuration: Round.
    - b. Minimum Port Area: 80 percent of nominal pipe area for valves 12 inches and smaller;
  7. Seats:
    - a. Full 360 degree seating by contact of a resilient seating material on the plug mating with welded-in seating surface in the body.
    - b. Screw in body seats not acceptable.
    - c. Resilient and of the continuous interface type having consistent opening and closing torques.
    - d. Non-jamming in the closed position.
  8. Stem Bearings: Self-lubricating.
  9. Stem Seals:
    - a. Type: V-ring.
    - b. Externally adjustable and repackable without removing the bonnet from the valve, or self adjusting.
  10. Packing and Gland: Accessible and externally adjustable.
- C. Operation:
1. A suitably sized steel actuator mounting bracket shall be provided to provide an air gap between the actuator and the valve stem seal. Under no circumstance shall the gear box be mounted directly to the top body flange such that leakage could directly enter the gear box.
  2. Coordinate with owner, instrumentation and electrical. Switches are not typically needed for smaller, manual valves.
  3. Provide adjustable limit stops for both opening and closing and a clearly marked position indicator.
  4. 4 Inches and Smaller: Manual, provided with its own securely attached lever.
  5. Greater Than 3 Inches: Worm gear manual operators with handwheel.
  6. Furnish chain wheel operators for valves mounted over 6 feet above operating floor.

D. Materials:

1. Body:
  - a. Cast iron, AWWA C517.
  - b. Lining: Elastomer, as recommended by valve manufacturer for service conditions.
2. Plug:
  - a. Cast iron, AWWA C517.
  - b. Lining: Resilient coating, as recommended by valve manufacturer for service conditions.
3. Seats: Stainless steel.
4. Stem: Type 316 stainless steel.
5. Stem Bearings: Stainless steel.
6. Seals: PTFE.
7. Connecting Hardware: [Type 316 stainless steel]

2.13 KNIFE GATE VALVES – Tag Type KGV3, VPKG3

A. Manufacturers:

1. Dezurik Model H-200-BV-T304.
2. Fabri-Valve CF134R.
3. Substitutions: As specified in Section 016000 - Product Requirements

B. Description:

1. Working Pressure: 10 psig
2. Maximum Fluid Temperature: 250 deg. F
3. Body:
  - a. Mark valves for direction of flow with cast wedges and gate guides in the body to force the gate against the seat.
4. Design:
  - a. Pressure-retaining bonnet that fully encloses the gate.
  - b. Bonnet rated at the same pressure as the valve body; internal gate packing or gate wiper not permitted.
  - c. Beveled knife edge gate.
  - d. 2 inch flush and drain ports same material as the wetted parts.
  - e. 3/4 inch flush and drain ports same material as the wetted parts.
  - f. Type 316 SS body cladding and face rings fully welded to the carbon steel body – "floating" body liners not permitted.
  - g. Stainless steel welding pickled and passivated per ASTM A380, A967.

- h. Valves 20 inches and larger, provide hardened gate support strips for valve gates oriented on edge.
  5. Packing:
    - a. Provide packing gland at the top of the bonnet to achieve a tight seal around the stem.
    - b. Design Yoke to support the operator without any movement or twisting at the stall thrust capability of the operator
    - c. Packing: replaceable without disassembling the valve or removing the valve from the pipeline.
  6. Stem:
    - a. Rolled Acme threads.
  7. Seats:
    - a. Metal to metal integral stainless-steel seating, with raised seat face and relief groove to allow the gate to push solid particles aside to prevent material packing in the seat area.
    - b. Install bar wedges and gate guides in the liner body to force the gate against the seat.
  8. End Connections:
    - a. Raised face flanged:
      - 1) ANSI 125/150 drilling.
      - 2) Machine groove flange faces to comply with MSS SP-6.
      - 3) Thread flange bolt holes.
  9. Actuator:
    - a. Handwheel
      - 1) Handwheel sized to seat and unseat the knife gate valve at the specified operating pressure with a maximum rim pull of 40 lb.
      - 2) If necessary to achieve 40 lb rim pull, provide a bevel gear operator.
        - a) Fully enclosed and permanently lubricated, with a sealed housing to prevent contamination.
        - b) Provide a stem cover to protect the stem when the valve is in the open position.
- C. Materials:
1. Body: Type 304 Stainless Steel
  2. Gate: Type 316 stainless steel
  3. Hardened Gate Support Strips: Satellite
  4. Connecting Hardware: Fabricated steel.

5. Stem: Type 316 stainless steel
    - a. Stem nut: acid resistant bronze.
  6. Yoke: Carbon steel
  7. Packing Gland & Bolts: Type 316 stainless steel
    - a. Nuts: naval bronze.
  8. Sealing Packing: Teflon-impregnated synthetic fiber
- D. Finishes:
1. Polish gate to a surface finish of 32 micro-inch RMS or better.
- 2.14 REDUCED PRESSURE ZONE BACKFLOW PREVENTER (RPZ)
- A. Size as indicated on the Drawings and body to be constructed of bronze for sizes less than 2-1/2-inch.
  - B. Each unit shall be complete with two companion full bore ball valves equipped with test connections. Valves shall be of similar material as that of the backflow device body. Unit shall have replaceable bronze seats and captured springs.
  - C. Each unit shall be provided with a complete set of spare parts, which shall be stored adjacent to the unit in a wood crate labeled with list of contents.
  - D. Unit shall be supported on galvanized steel floor stanchions with floor flange secured to floor.
  - E. Unit shall be of the manufacturer that meets the approval of the authority having jurisdiction. Submittal for approval shall be accompanied by the authority's "acceptable device list" or alternatively by their written approval.
  - F. Acceptable manufacturers shall include Watts Regulator; Zurn; Cla-Val Co. or equal.
- 2.15 GATE VALVES (2-1/2-IN AND SMALLER)
- A. Gate valves 2-1/2-in diameter and smaller shall have screwed ends as required and shall be brass, or bronze body, solid wedge, union bonnet, rising-stem gate valves rated for a working pressure of 200 psi WOG such as Figures 47-U as manufactured by Jenkins Brothers or similar products as manufactured by Crane; Fairbanks; Kennedy Valve Manufacturing Co.; Lukenhiemer or equal.

## 2.16 GATE VALVES (3-IN AND LARGER)

- A. General Requirements. Valves shall be solid wedge, or resilient seated, as indicated on the Drawings or as specified herein for class of service.
1. Unless otherwise specified below, these requirements shall apply to all gate valves 3-in and larger.
  2. Gate valves shall meet the requirements of AWWA C500 and AWWA C509 as applicable to the type of valve specified.
  3. Submerged valves shall be furnished with mechanical joints and stainless steel hardware; non-rising stem design with 2-in operating nut.
  4. Exposed valves shall be furnished with Class 125 flanged ends and provided with outside screw, yoke and handwheel operator.
  5. All-metal valves shall be manufactured of ASTM A126 Cast Iron, Class B, with bronze mounting design.
  6. Rising stem valves shall be sealed with adjustable and replaceable packing; valve design must permit packing replacement under operating system pressures with only moderate leakage.
  7. Non-rising stem valves shall use a double O-ring stem seal, except that packing shall be used where geared operators are required.
  8. Except as otherwise specified, valves shall be rated for a working pressure of 150 psi:
    - a. Valve bodies shall be hydrostatically tested to at least twice the rated working water pressure. In addition, valves shall be seat-tested, bi-directional at the rated working pressure, with seat leakage not to exceed one fluid ounce per inch of valve diameter per hour. Provide certificates of testing.
  9. Flanged valves to have face-to-face dimensions per ANSI B16.10 and flanges per ANSI B16.1.
  10. All bonnet and packing gland bolts shall be zinc or cadmium electroplated steel; packing gland bolts shall have bronze nuts.
  11. All valves shall be marked per AWWA Standards, including name of manufacturer, valve size working pressure and year of manufacture.
  12. Unless otherwise indicated, valves 12-in and smaller shall be capable of installation in the vertical or horizontal position, and sealing in both directions at the rated pressure.
  13. Valve operation shall be counterclockwise. Provide permanent label showing "OPEN" and arrows.
  14. Metal-seated valves shall be coated internally and externally with an asphaltic varnish, per AWWA C500. Resilient seated valves shall be coated, interior and exterior, with fusion bonded epoxy per AWWA C550.
- B. Valve Applications
1. Valves for Potable, Wastewater, Plant Water or Protected Water Service
    - a. Resilient seated design manufactured by American-Darling Valve; Kennedy Valve; M&H Valve; Clow Corp or equal.
- C. Valve Requirements

1. Resilient Seated

- a. Conform to AWWA C509. Also UL and FM approved.
- b. Internal and external epoxy coating of valve body, including bonnet, per AWWA C550.
- c. Gate shall be encapsulated with synthetic rubber. It shall be bonded and vulcanized in accordance with ASTM B429 Method B.
- d. No recesses in valve body.

D. Tapping Valves and Sleeves

1. Tapping valves shall comply with the same requirements as solid wedge gate valves except they shall have the flanged end and port opening modified for tapping service. Valves shall be capable of passing a full nominal sized cutter without damage to the valve. The tapping sleeve shall be gray cast iron or ductile iron mechanical joint type with the outlet flange conforming to MSS-SP-60.

2.17 INSULATION

- A. As specified in Section 404213 "Process Piping Insulation."

2.18 FINISHES

- A. Valve Coating: Comply with AWWA C550.
- B. Exposed Valves: As specified in Section 099000 "Painting and Coating."
- C. Do not coat flange faces of valves unless otherwise specified.

2.19 SOURCE QUALITY CONTROL

- A. Ball Valve Testing: According to AWWA C507.
- B. Plug Valve Testing: Hydrostatic Test Per ANSI B16.1 and B16.5.
  1. Submit an affidavit of compliance stating that the valves have been manufactured and tested in accordance with AWWA C504-00, Section 5.2.4 and specifically list all exceptions.
  2. Perform a valve seat leakage test, for 3 valves of size 24/36/48 to be witnessed by the Engineer to prove compliance with this Section.
- C. Provide shop inspection and testing of completed assembly.
- D. Project Officer Inspection:
  1. Make completed assembly available for inspection at manufacturer's factory prior to packaging for shipment.
  2. Notify Owner at least twenty-one days before inspection is allowed.



- E. Certificate of Compliance:
  - 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
- F. Specified shop tests are not required for Work performed by approved manufacturer.
- G. Testing Swing Check Valves, Ball Valves, Plug Valves, Knife Gate Valves, Gate Valves, :
  - 1. Hydrostatically test check valves at twice rated pressure according to AWWA C508.
  - 2. Permitted Leakage at Indicated Working Pressure: None.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that piping system is ready for valve installation.
- B. Verify that field dimensions are as indicated on Shop Drawings.
- C. Inspect existing flanges for nonstandard bolt-hole configurations or design and verify that new valve and flange mate properly.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Thoroughly clean end connections before installation.
- B. Cleaning: Clean surfaces to remove foreign substances.
- C. Surface Preparation:
  - 1. Touch up shop-primed surfaces with primer as specified in Section 099000 "Painting and Coating."
  - 2. Solvent-clean surfaces that are not shop primed.
  - 3. Clean surfaces to remove loose rust, mill scale, and other foreign substances by [power wire brushing. Prime surfaces as specified in Section 099000 "Painting and Coating."

#### 3.3 INSTALLATION

- A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.
- B. Firmly support valves to avoid undue stresses on piping.
- C. Coat studs, bolts and nuts with anti-seizing lubricant.

- D. Clean field welds of slag and splatter to provide a smooth surface.
- E. Install valves with stems upright or horizontal, not inverted.
- F. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.
- G. Install 3/4-inch gate and ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.
- H. Install valves with clearance for installation of insulation and to allow access.
- I. Provide access where valves and fittings are not accessible.
- J. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.
- K. Install insulation as specified in Section 404213 "Process Piping Insulation."
- L. Install protective strainers upstream of solenoid valves, pressure-reducing valves, and pressure-sustaining valves.
- M. According to manufacturer instructions and local code requirements.
- N. Repair damaged coatings with material equal to original coating.
- O. Swing Check Valves: According to AWWA C508 and manufacturer instructions.
- P. Ball Valves: According to AWWA C507.
- Q. Plug Valves: According to AWWA C517.
  - 1. Horizontal Piping: Stem horizontal, Plug opening to crown of body.
  - 2. Vertical Piping: Plug at top when closed.
  - 3. Plugs: On top when open and on pressure side when closed.
- R. Dielectric Fittings: Provide between dissimilar metals.

### 3.4 FIELD QUALITY CONTROL

- A. Valve Field Testing:
  - 1. Test for proper alignment.
  - 2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
  - 3. Engineer/Engineer will witness field testing.
- B. Testing: Test each valve for leak tightness at 75 percent of set point according to API 2000.
- C. After installation, inspect for interferences and proper supports.

- D. Repair damaged coatings with material equal to original coating.
- E. Inspection:
  - 1. Inspect for damage to valve lining or coating and for other defects that may be detrimental as determined by Engineer/Engineer.
  - 2. Repair damaged valve or provide new, undamaged valve.
  - 3. After installation, inspect for proper supports and interferences.
- F. Pressure test valves with piping.

### 3.5 CLEANING

- A. Keep interior of valves clean as installation progresses.
- B. After installation, clean valve interior of soil, grit, loose mortar, and other debris.

### 3.6 DEMONSTRATION

- A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Prepare test and inspection reports.

END OF SECTION 400551



## SECTION 400553 - IDENTIFICATION FOR PROCESS PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Labels.
6. Lockout devices.

- B. Related Requirements:

1. Section 099100 "Painting" for requirements for painting as specified by this Section.
2. Section 400551 "Process Valves" for basic materials and methods for valves.
3. Section 404213 "Process Piping Insulation."

#### 1.3 PREINSTALLATION MEETINGS

- A. Section 013100 "Project Management and Coordination" for requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

#### 1.4 SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.
- B. Product Data: Submit manufacturer's catalog literature for each specified product.
- C. Shop Drawings:
  1. Indicate list of wording, symbols, letter size, spacing of labels, and color-coding for mechanical identification and valve chart and schedule.
  2. Indicate valve tag number, location, function, and valve manufacturer's name and model number.

- D. Samples: Submit one labels for each size to be used on Project.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Qualifications Statement:
  - 1. Submit qualifications for manufacturer.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 "Execution and Closeout Requirements" for requirements for submittals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 017000 "Execution and Closeout Requirements" for requirements for maintenance materials.
- B. Extra Stock Materials: Furnish two containers of spray-on adhesive.
- C. Tools: Furnish special crimpers for Owner to reinstall tags.

#### 1.7 QUALITY ASSURANCE

- A. Piping Color Scheme and Lettering Size: Comply with ASME A13.1.
- B. Perform Work according to Arlington County standards.
- C. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.

## PART 2 - PRODUCTS

### 2.1 NAMEPLATES

#### A. Manufacturers:

1. Craftmark Pipe Markers,
2. Kolbi Pipe Marker Co.,
3. Pipemarket.com (Brimar Industries, inc.),
4. Seton Identification Products
5. Substitutions: Not permitted

#### B. Description: Laminated three-layer plastic with engraved white letters on black background.

### 2.2 TAGS

#### A. Metal Tags:

##### 1. Manufacturers:

- a. Brady ID,
- b. Craftmark Pipe Markers,
- c. Kolbi Pipe Marker Co,
- d. Marking Services, Inc.,
- e. Pipemarket.com (Brimar Industries, Inc.),
- f. R&R Identification Co.
- g. Seton Identification Products
- h. Substitutions: Not permitted.

##### 2. Description:

- a. Stainless-steel construction; stamped letters.
- b. Minimum Tag Size and Configuration: 2 inches; square with finished edges.
- c. Provide with brass hooks suitable for attaching the tag to the valve operator.
- d. Stamp or etch tags with the valve number and information on the valve schedule coded in a system provided by the Owner.

#### B. Information Tags:

##### 1. Manufacturers:

- a. Brady ID,
- b. Seton Identification Products
- c. Substitutions: Not Permitted.

##### 2. Description:

- a. Up to six (12) Clear plastic with printed text to be defined by the Owner's health and safety officer.
- b. Minimum Tag Size: 3-1/4 by 5-5/8 inches.

- c. Furnish grommet and self-locking nylon ties.
- 3. Tag Chart: Typewritten, letter-size list of applied tags and location, plastic laminated.

## 2.3 STENCILS

### A. Manufacturers:

- 1. Kolbi Pipe Marker Co,
- 2. Marking Services, Inc.,
- 3. Pipemarket.com (Brimar Industries, Inc.),
- 4. R&R Identification Co.
- 5. Seton Identification Products
- 6. Substitutions: Not Permitted

### B. Description:

- 1. Quality: Clean-cut symbols.
- 2. Letters:

OUTSIDE DIAMETER OF PIPE	SIZE OF LETTERS
3/4-in to 1-1/4-in	1/2-in
1-1/2-in to 2-in	3/4-in
2-1/2-in to 6-in	1-1/2-in
8-in to 10-in	2-1/2-in
Over 10-in	3-in

### C. Stencil Paint:

- 1. Description: Semigloss enamel.
- 2. As specified in Section 099100 "Painting."

## 2.4 PIPE MARKERS

### A. Plastic Pipe Markers:

- 1. Manufacturers:
  - a. Brady ID,
  - b. Craftmark Pipe Markers,
  - c. Marking Services, Inc.,
  - d. R&R Identification Co.,
  - e. Seton Identification Products Substitutions: Not Permitted
- 2. Description:
  - a. Factory-fabricated, flexible, and semi-rigid plastic.
  - b. Preformed to fit around pipe or pipe covering.



- c. Larger sizes may be of maximum sheet size, with spring fastener.
- d. Letter sizes per Article "Stencils."
- e. Color coded to match plant standards/existing

B. Plastic Tape Pipe Markers:

1. Manufacturers:

- a. Brady ID,
- b. Craftmark Pipe Markers,
- c. Kolbi Pipe Marker Co.,
- d. Marking Services, Inc.,
- e. Pipemarket.com (Brimar Industries, Inc.),
- f. Seton Identification Products
- g. Substitutions: Not Permitted

2. Description:

- a. Flexible, 3.5 mil vinyl ilm tape with pressure-sensitive adhesive backing and printed markings.
- b. Letter sizes per Article "Stencils."
- c. Color coded to match plant standards/existing.

## 2.5 LABELS

A. Manufacturers:

1. Brady ID,
2. Seton Identification Products
3. Substitutions: Not permitted.

B. Description:

1. Material: Laminated Mylar.
2. Minimum Size: 1.9 by 0.75 inches.
3. Adhesive backed, with printed identification.

## 2.6 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

- a. Brady ID,
- b. Master Lock Company, LLC
- c. Substitutions: Not permitted.

2. Description:

- a. Material: Reinforced nylon.

- b. Furnish hasp with erasable label surface.
- c. Minimum Size: 7-1/4 by 3 inches.

B. Valve Lockout Devices:

- 1. Manufacturers:
  - a. Brady ID,
  - b. Master Lock Company, LLC
  - c. Substitutions: Not permitted.
- 2. Description:
  - a. Material: Nylon.
  - b. Furnish one device for each size and type of valve to restrict access to valve operator and to accept lock shackle.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Section 017000 "Execution and Closeout Requirements" for requirements for installation preparation.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Stencil Painting: Prepare surfaces as specified in Section 099100 "Painting."

#### 3.2 INSTALLATION

- A. According to manufacturer instructions.
- B. Apply stencil painting as specified in Section 099100 "Painting."
- C. Install identifying devices after completion of coverings and painting.
- D. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.
- E. Labels:
  - 1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
  - 2. For unfinished covering, apply paint primer before applying labels.
  - 3. Titles:
    - a. Locate a maximum 15 feet apart.
    - b. Locate directly adjacent to pipeline breaches on each side wall.
    - c. Locate adjacent to each side of the valve regulator, flow meter, strainer, cleanout and all pieces of equipment.
    - d. Identify the contents by complete name at least once in each room or space and thereafter may be labeled by generally recognized abbreviations.

F. Tags:

1. Identify valves in main and branch piping with tags.
2. Install tags using corrosion-resistant chain.
3. Number tags as indicated in tag schedule.

G. Piping:

1. Identify piping, concealed or exposed, with plastic pipe markers or stenciled painting.
2. Use tags on piping 3/4-inch diameter and smaller.
3. Identify service, flow direction, and pressure.
4. Install in clear view and align with axis of piping.
5. Locate identification not to exceed 15 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 400553



## SECTION 400557 - ACTUATORS FOR PROCESS VALVES AND GATES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Manual actuators.
- 2. Electric motor actuators.

- B. Related Requirements:

- 1. Section 260519 “Low-Voltage Electrical Power Conductors and Cables” for motor connections for electric actuators.
- 2. Section 400507 “Hangers and Supports for Process Piping” for hangers, anchors, sleeves, and sealing of piping to adjacent structures.
- 3. Section 400551 “Process Valves” for common product requirements for valves for placement by this Section.
- 4. Section 400593.23 “Common Motor Requirements for Process Equipment” for motors for electric actuators.

#### 1.3 COORDINATION

- A. Section 400551 “Process Valves” for valve schedule.
- B. Coordinate Work of this Section with installation of valves and accessories.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information for actuator with model number and size indicated.
- B. Shop Drawings:
  - 1. Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, control system schematics will all external interfaces on assembly drawings.
  - 2. Submit actuator Shop Drawings with valve and gate submittal.
  - 3. Individual electrical control schematics and wiring diagrams for each valve operator with external interfaces, identified exactly as detailed on Electrical and Instrumentation

Drawings. Standard catalogue cut sheets that show typical wiring diagrams only are not acceptable. Coordinate valve actuators with electrical requirements indicated on Drawings and valves as specified herein.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Manufacturer Instructions: Submit special procedures and placement requirements.
- C. Source Quality-Control Submittals: Indicate results of factory tests and inspections and provide required certifications.
- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- E. Qualifications Statements:
  - 1. Submit qualifications for manufacturer and installer.
  - 2. Submit manufacturer's approval of installer.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations and types of actuators.

#### 1.7 QUALITY ASSURANCE

- A. Valve Actuators in NEC Class I, Group C and D, Division 1 or 2 Hazardous Locations: Comply with NFPA 70.
- B. Perform Work according to Arlington County standards.
- C. Maintain 3 copies of each standard affecting Work of this Section on Site.
- D. Valve actuators of the same type to be the product of one manufacturer, Contractor to coordinate this requirement with actuated valves included in the scope of vender furnished equipment.
- E. Mate valves to actuators at manufacturers or integrators facility. Fully test assembled product and certify ready for installation prior to shipment to the job site. Only in special cases for extremely large assemblies where installation requires disassembly may the actuator be mounted to the valve in the field.
- F. Provide installation inspection and operator training in accordance with Section 400551 "Process Valves."

## 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
  - 3. Provide additional protection according to manufacturer instructions.

## 1.10 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

## 1.11 WARRANTY

- A. Furnish five-year manufacturer's warranty for electric-motor actuators.

## PART 2 - PRODUCTS

### 2.1 DESCRIPTION

- A. Actuators to move the valve or gate from the full open to full closed position and back again. Unless otherwise noted, provide all valves with manual actuators that utilize an operating wheel, handle or lever. Where noted, furnish the appropriate accessories to operate valves or gates provided with 2-inch operating nuts. Furnish gear manual actuators where manual operator effort is greater than 40 ft-lb rim pull. Furnish power actuators or pneumatic actuators where noted for remote operation of the valve.

## 2.2 MANUAL ACTUATORS

### A. General

1. Direction of rotation to be counterclockwise to open the valve or gate, unless otherwise noted.

### B. Operating Nuts

1. Provide handwheel or minimum of two tee handles or levers for every 10 valves for non-rising valve or gate stem application with 2-inch AWWA operating nut.
2. Tee handle extension length for buried valves to be determined based on nut height as indicated on the Drawings and achieving a minimum height of 3 feet above finished grade.
3. For operating nuts recessed on concrete, provide cast iron floor box with cover and operating keys.
4. Provide pipe extensions through concrete as required to accommodate stem extensions. Provide extension stem couplings rated at least five times the maximum operating torque.
5. For support of extension stems, provide wall bracket type stem guides every 10-feet. Guides to be adjustable of cast iron with bronze bushing.

### C. Floor Stands with Actuators

1. For rising stem valve or gate stem applications, provide extension stems and guides with a cast iron floor stand 36-inch high, bolted to concrete floor or heavy reinforced wall bracket.
2. Mount a manual handwheel on top of floor stand. Where manual effort is greater than 40 ft-lb rim pull, provide geared actuator with a handwheel or crank.
3. Handwheel casting to include the word "OPEN" and an arrow indicating the direction of operation.
4. Supply fracture-resistant clear polycarbonate stem covers. Top to be closed and have indicator markings to indicate valve/gate position.

## 2.3 ELECTRIC MOTOR ACTUATORS

### A. Description:

1. Electric motor, reduction gearing, limit switches, torque switches, and integral control station or remote control stations as indicated on the Drawings.
2. Comply with AWWA C542.
3. Actuators to be rated for 480 Volt, 3 Phase, 60 Hz power supply.
4. Actuators to be designed to match the valve or gate applications for either ¼ turn or multi-turn and for either open/close or modulation operation as noted in the valve or gate schedule.

### B. 480 Volt Power Actuators

1. Self-contained, totally enclosed including reversing motor, reduction gearing, limit switch gearing, limit switches, control power transformer, torque switches, bored and



- keyed drive sleeve for non-rising stems, declutch lever, auxiliary handwheel, and local position indication.
2. Actuators to have separately sealed motor and control compartments and have space heaters in their limit switch, motor, and control compartments,
  3. Multi-turn actuators to provide an output speed of 1 foot per minute of travel and quarter turn actuators to be designed to rotate from open to close in 30 seconds per foot of throat diameter.
  4. Where noted in the valve and gate schedule, actuator enclosure to be:
    - a. NEMA 4 for watertightness from a pressure hose
    - b. NEMA 7 for Class 1 Division 1 & 2, Groups C & D hazardous environment.
  5. Motors:
    - a. High starting torque type, total enclosed non-ventilated type (TENV),
    - b. Thermistor embedded in each motor winding for thermal protection
    - c. Sized to provide the required output torque for the service intended.
    - d. Class F insulation, with a duty rating of at least 15 minutes at 40 degrees C ambient temperature.
    - e. Actuator to include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel regardless of the connection sequence of the power supply.
  6. Integral and Remote Control Station:
    - a. Microprocessor based with mechanically and electronically interlocked reversing contactors for Open/Close duty and solid-state contactors for modulating duty.
    - b. Provide Hand/Off/Auto selector switch and Open/Stop/Close selector switch controls mounted on the face of the actuator with red and green indications lights for opened/closed and amber for fault.
    - c. Remote Open/Close service: the actuator will accept one remote signal to open and a second remote signal to close.
    - d. Monitoring relays to be provided to remotely indicate fault signal for indication of power failure, phase failure, thermal switch tripped, torque switch tripped between travel stops and Hand/Off/Auto selector switch position.
    - e. Transmitter to be provided with easily accessible zero and span adjustment potentiometers.
    - f. The DC power supply to be provided integral with the operator and powered from the 110-volt AC internal transformer. Positioner board to provide repeatable accuracy to 0.25% of span and have separate trim pots for zero, span and dead band adjustment.
    - g. Do not provide actuators with Remote Control Stations as indicated on the Drawings with Integral Control Stations.
  7. Position Indication: Provide continuous mechanical dial indication of valve position that is in step with the actuator at all times in both the hand wheel and motor operation.
  8. Limits Switches:
    - a. Adjustable type to trip at any point between fully opened valve and fully closed.
    - b. Mid-travel switches to be provided as noted.
    - c. Set position will not be lost if over travel occurs in either manual or electric modes of operation.

- d. Provide two independent and fully adjustable rotary type position limit switches each with 15 Amp DPDT contacts for remote open/close valve position indication.
9. Torque switches: Provide actuator with adjustable torque switches and be responsive to load encountered in either direction of travel.
10. Terminal compartment:
  - a. Separate from the inner electrical components of the actuator and provide with a watertight seal.
  - b. Provide three threaded cable entries.
  - c. Stud-type terminals embedded in a terminal block of high tracking-resistance compound.
  - d. Three-phase power terminals to be shrouded from the control terminals by means of an insulating cover.
11. Products: Subject to compliance with requirements, provide one of the following:
  - a. Rotork IQ/IQM
  - b. Limitorque MX
  - c. EIM TEK 2000
  - d. AUMA SA/SAR

## 2.4 SOURCE QUALITY CONTROL

### A. Factory Testing

1. Provide shop inspection and testing of completed assemblies.
2. Each actuator must be factory performance tested, and individual test certificates supplied. Test certificates to be submitted prior to shipment of valve actuators. Test equipment to simulate a typical valve load, and record the following parameters:
  - a. No load current.
  - b. Current at maximum torque setting.
  - c. Stall current.
  - d. Torque at maximum torque setting.
  - e. Stall torque.
  - f. Test voltage and frequency.
  - g. Flash test voltage.
  - h. Actuator output speed.

### B. Owner Witnessing:

1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Notify Owner at least fourteen days before inspections and tests are scheduled.

### C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field dimensions are as indicated on Shop Drawings.

### 3.2 INSTALLATION

- A. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.
- B. Extend chain actuators to 5-1/2 feet above operating floor level.

### 3.3 FIELD QUALITY CONTROL

- A. After installation, inspect for proper supports and interferences.
- B. Repair damaged coatings with material equal to original coating.

END OF SECTION 400557



## SECTION 400559.23 - STAINLESS STEEL SLIDE GATES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes: Stainless-steel slide gates.
- B. Related Requirements:
  - 1. Section 400551 "Common Work Results for Process Valves."
  - 2. Section 400557 "Actuators for Process Valves and Gates."
  - 3. Section 400553 "Identification for Process Piping."

#### 1.3 DEFINITIONS

- A. Operating Head: Distance from centerline of gate to maximum water level of channel.

#### 1.4 COORDINATION

- A. Section 013100 "Project Management and Coordination" for requirements for coordination.
- B. Coordinate Work of this Section with Work of other Sections.

#### 1.5 ACTION SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.
- B. Product Data: Submit manufacturer's product information for system materials and component equipment.
- C. Shop Drawings:
  - 1. Indicate system materials and component equipment.
  - 2. Complete description of all materials cross-referenced to a sectional drawing listing material by trade name and ASTM reference number.
  - 3. Certified shop and installation Drawings showing all details of construction, dimensions and anchor bolt locations. Submit installation and anchoring requirements, fasteners, and other details.
  - 4. Descriptive literature, bulletins and/or catalogs of the equipment.

5. The weight of each component.
  6. Description of surface preparation and shop prime painting of gates and accessories.
  7. Indicate gate identification number, location, service, type, size, design pressure, operator details, stem details, and loads.
  8. A listing of all forces transmitted to floor stands if applicable.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
1. Certify that installation is completed according to manufacturer's instructions.
- E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- F. Source Quality-Control Submittals: Indicate results of shop tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Manufacturer Reports:
1. Certify that equipment has been installed according to manufacturer's instructions.
  2. Indicate activities on Site, adverse findings, and recommendations.
- I. Qualifications Statements:
1. Submit qualifications for manufacturer and licensed professional.
- 1.6 DELEGATED DESIGN SUBMITTALS
- A. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating pressure.
- 1.7 CLOSEOUT SUBMITTALS
- A. Section 017300 and 017700 "Execution" and "Closeout Requirements" for requirements for closeout procedures.
- B. Project Record Documents: Record actual locations of installed slide gates and components.
- C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.
- 1.8 MAINTENANCE MATERIAL SUBMITTALS
- A. Section 017300 and 017700 "Execution" and "Closeout Requirements" for requirements for maintenance materials.
- B. Spare Parts:
1. Furnish one set of manufacturer's recommended spare parts.

- C. Tools: Furnish special tools and other devices required for Owner to maintain equipment. Provide special tools and spare parts required for normal operation and maintenance of the equipment.
- D. O&M Manual: Furnish four copies of manufacturer's operation and maintenance manual(s).
- E. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data and full preventive maintenance schedules.
- F. A factory representative who has complete knowledge of proper operation and maintenance shall be provided for four days to instruct representatives of the Owner on the proper operation and maintenance of the equipment.

#### 1.9 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF Standard 61 and NSF Standard 372.
- B. Perform Work according to State, Local, and County standards.

#### 1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the Commonwealth of Virginia.

#### 1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store and protect materials according to manufacturer's instructions.

#### 1.12 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

### 1.13 WARRANTY

- A. Section 017300 and 017700 “Execution” and “Closeout Requirements” for requirements for warranties.
- B. Furnish three -year manufacturer's warranty for slide gates.
- C. Furnish five-year manufacturer's warranty that clear plastic stem covers will not crack, discolor, or become opaque.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Provide six electrically actuated slide gates downstream of the bar screens, as indicated on the drawings.
  - 1. Seating Pressure:
  - 2. 2 feet 6 inches of water.
  - 3. Measurement: From maximum water surface to centerline of gate.
- B. Minimum Vertical Loading: 50 percent of force on the gate from operating head acting on horizontal centerline of gate, multiplied by effective gate area, plus weight of slide and stem.
- C. Gate Reinforcement: As required for deflection not greater than 1/360 of span.
- D. Operating Head:
  - 1. Safety Factor: Design gate to operate under specified operating head with safety factory of five.

### 2.2 STAINLESS-STEEL SLIDE GATES

- A. Manufacturers:
  - 1. Whipps
  - 2. Hydrogate
  - 3. Engineer Approved Equal
  - 4. Furnish materials according to State, Local, and County standards.
- B. Description:
  - 1. Comply with AWWA C561.
  - 2. Self-contained stainless-steel slide gate, with extended frame, yoke, lifting stem attached to yoke, lift and lift support, stem, stem guide, and stem block.
  - 3. Size: 6 feet high by 3 feet 6 inches wide
    - a. Dimensions to be verified by the Contractor prior to fabrication.



4. Operating Head: 6 feet
5. Closure: Bottom flush
6. Opening: Upward

C. Gates:

1. Material:
  - a. Type 316 stainless steel, self-contained type with the gate arranged to lower or raise to open and with the guides designed to mount embedded in concrete.
2. The sliding member shall be of Type 316 and the stainless-steel plate reinforced with "U" or angle-shaped stainless-steel members welded to the plate not more than 16-in apart. The disc shall not deflect more than 1/360 of the span of the gate under the design head. Reinforcing ribs shall extend into the guides so that they overlap the seating surface of the guide. A specially molded resilient seal shall be mounted on the bottom of embedded unit discs or on the edge of the disc to provide flush bottom closure. The shape of the seal shall produce a seating surface having a minimum width of 3/4-in and the seal shall extend into the secondary slot of the guide. The vertical face of the seal shall be in contact with the seating surface of the guide to provide a proper seal at the corners. Reinforcements, retainer and bolts shall be of the same material as the disc. The invert of embedded unit frames shall have an angle welded to the lower ends of the guides to form a seating surface for a resilient seal mounted on the disc. Angle shall be of the same material as the guides.
3. Minimum Thickness: 1/4-in
4. Configuration: Removable.

D. Guides:

1. The guides shall be of Type 316 stainless steel construction. The guides shall be designed for maximum rigidity, shall have a weight of not less than three lbs/ft and will be provided with holes for anchor bolts every 18-in for face mounted units or embedding keyways for embedded units. Guides shall extend beneath the opening a sufficient amount to support the disc in the fully down or open position for downward opening gates.
2. An angle shall be welded to the guides across the invert of the opening on face-mounted gates and up both sides of all gates. A hollow bulb "J" or "P"-seal will be attached to this angle with stainless steel strips and attaching bolts. The seal shall be arranged so that it will deflect a minimum of 1/16-in. Angle, strips and bolts shall be the same material as the guides.
3. Where the guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcing will be required. Where required, the yoke to support the operating bench stand will be formed by two angles welded at the top of the guides to provide a one-piece rigid frame. The arrangement of the yoke will be such that the disc and stem can be removed without disconnecting the yoke.

E. Yokes:

1. Material: Type 316 Stainless Steel.
2. Mounting: Bolted to gate frame.

3. The arrangement of the yoke shall be such that the disc and stem can be removed without disconnecting the yoke.

F. Seats:

1. Impacted into dovetail slots and held in position without use of screws or other fasteners.
2. Maximum Clearance between Seating Faces: 0.004 inch when gate is fully closed.

G. Wedges:

1. Description: Machined brass blocks with angled faces and secured with a stud bolt to prevent slippage during operation.
2. Provide side, top, and bottom wedges.

H. Frames:

1. Configuration: One piece.
2. Mounting: Embedded.
3. Material: Type 316 stainless steel.
4. Furnish continuous embed.
5. Thickness: 1/4 inch.
6. Seats: Ultra-high-molecular-weight polymer.
7. Bottom Flush Closure: Resilient seal securely attached to frame along invert.

I. Lifting Devices:

1. Description: Stem, lifting nut, supports, bushings, stem cover, position indicator, and electric-motor actuator.
2. Mounting: Type 316 stainless steel pedestal.
3. Powered Lift Devices:
  - a. As specified in Section 400551 - Common Work Results for Process Valves.
  - b. Comply with AWWA C541 and AWWA C542.
4. Hand-Lifted Gates: Provide stainless-steel lifting handle.

J. Operators:

1. Material: Type 316 stainless Steel
2. Type: Handwheel
3. Diameter: 16 inches.
4. Configuration: Removable.
5. Fully lubricated.
6. Mounting: Locate center of handwheel 36 inches above operating floor.
7. A side mount or front mount operator system utilizing right angle bevel boxes, stainless steel interconnecting shafting, and flexible couplings shall be furnished by the manufacturer when the bench stand is located over 48-in above the operating floor. The transmission system design shall provide for the gate to be operated from a position 36-in above the operating floor.

8. Bevel boxes for the transmission system shall be provided with cadmium plated pinion shafts supported on roller bearings. A mechanical seal will be provided around the pinion shaft where it extends from the bevel box enclosure.
9. Floor stands shall be furnished for all other gate operators not supported on the gate yoke. Floor stands shall be cast iron or fabricated steel construction. The pedestal height shall be such that the crank shaft will be approximately 36-in above the operating floor. Wall brackets shall be used to support floor stands where shown on the Drawings and shall be furnished in cast iron or welded steel construction, designed to withstand all normal operating loads. Where shown on the Drawings, floor stands shall be offset type mounted on the floor surface and offset to align with the gate stem. The floor stand shall be mounted on a heavily ribbed reinforced cast iron bracket anchored to the concrete with Type 304 stainless steel anchors. The bracket and anchor bolts shall be sized to transfer the upward or downward thrust required to ultimately fail the stainless steel stem. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer and shall be approved by the Engineer. The bracket, anchors, backplate and accessories shall be supplied as part of the gate assembly by the gate manufacturer.
10. Manual operators shall be furnished where shown and shall consist of a handwheel or crank operator mounted on the gate yoke or on a floor stand, as indicated in the Drawings.
11. Handwheel operators shall have a minimum 18-in diameter handwheel and shall operate the gate under the specified operating head with not greater than 40 lbs of force on the handwheel. The operator shall be fully enclosed, equipped with roller bearings above and below the operating nut and mechanical seals. Alternatively, polyethylene bearing pads may be used.
12. Crank operators shall have either single or double gear reduction depending upon the lifting capacity required. Double reduction operators shall also be 2-speed type with a square nut drive on the high speed and low speed shafts. Each type shall be provided with a threaded cast bronze lift nut to engage the operating stem. Bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Operators shall be designed for a maximum crank effort of 40 lbs under the specified operating conditions. Gears, where required, shall be steel with machined cut teeth designed for smooth operation. The pinion shafts on crank-operated floor stands, either single or double ratio, shall be supported on tapered roller bearings and enclosed in a cast iron case and cover. Positive mechanical seals shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist. Lubricating fittings shall be provided for the lubrication of all gears and bearings. The crank shall be of cast iron with a revolving brass grip. The crank shall be removable.
13. Operators shall be equipped with fracture-resistant clear polycarbonate stem covers which shall not discolor or become opaque for a minimum of five years after installation. The top of the stem cover shall be closed. The bottom end of the stem cover shall be mounted in a housing or adapter plate for easy field mounting. Stem covers shall be complete with indicator markings to indicate gate position.
14. An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the gate. The direction of rotation to open shall be counterclockwise.
15. Electric operators shall be furnished where shown on the Drawings and shall be electric operated floor or bench stand mounted and shall include the motor, operator unit gearing, limit switch gearing, limit switches, torque switches, stem nut, declutch lever and auxiliary handwheel. The motor operator shall drive the gate stem at a rate of one foot per minute.

16. The motor shall be specifically designed for gate operator service and shall be continuous duty rated (modulating service only), of a high torque, totally enclosed non-ventilated construction with the motor leads brought into the limit switch compartment without having external piping or conduit box. The motor shall be of ample size to open or close the gate against maximum load when voltage to the motor terminals is within ten percent of the nominal voltage. It shall be pre-lubricated and all bearings shall be of the anti-friction type. Motors shall be of weatherproof construction unless otherwise shown and shall have encapsulated windings with void free slot penetration and be capable of passing water immersion test as outlined in NEMA MGI-20.48 to provide protection against moisture ingress and condensation when the motor is not running. Threaded condensate drain holes shall be suitably positioned on the lower external surface to expel any moisture that may have accumulated. Motor power requirements shall be as specified below. In addition, the motor shall conform to all applicable portions of Section 400593.23 and Section 400557 "Actuator for Process Valves and Gates."
17. The power gearing shall consist of carburized and hardened alloy steel worms with threads ground after heat treating. The worm gear shall be of alloy bronze, accurately cut with a hobbing machine. Where required, additional generated helical gears of heat treated steel shall be used. All power gearing shall be suitably lubricated with oil or grease and shall be suitable for mounting in any position. Ball or roller bearings shall be used throughout.
18. Limit switches and gearing shall be an integral part of the gate operator. The limit switch gearing shall be totally enclosed in its own gear case and permanently grease or oil lubricated. The limit switch mechanism shall be designed so that one set of limit switches is provided for each direction of travel and shall be provided with two normally open and two normally closed contacts per set of switches. The switches shall be adjustable to allow the switch to trip at any point on the gate's travel. The limit switches shall be geared to the drive mechanism and in step at all times whether the unit is in motor or manual operation. A mechanical gate position indicator shall be provided to indicate gate opening.
19. The gate control shall be equipped with a double torque switch. The torque switch shall be adjustable and shall be responsive to load encountered in either direction of travel. It shall operate during the complete cycle to protect the gate should excessive load be met because of obstruction in either direction of travel.
20. The operator shall have a stem nut of high tensile bronze for open-close service. Stem nuts for modulating service shall have a nylon stem nut. The nut arrangement shall be of the 2-piece type to simplify field replacement. The stem nut shall be capable of being removed from the top of the operator without the necessity of removing the operator from the floor stand or disassembling any of the gearing within the operator.
21. A handwheel shall be provided for manual operation. The handwheel shall not rotate during electric operation, but shall be responsive to manual operation at all times except when the motor is in operation. The motor shall not rotate during hand operation, nor shall a fused motor prevent hand operation. When in the hand operating position, the unit shall remain in this position until the motor is energized, at which time the operator shall automatically return to electric operations and shall remain in the electric position until hand operation is again desired. This movement from electric to hand operation shall be accomplished by a positive declutching lever which shall disengage the motor and motor gearing mechanically, but not electrically. It shall be impossible to place the unit in hand operation when the motor is running. When in hand operation, not more than 40 lbs of force shall be required on the handwheel for operation of the gate. An arrow shall be cast on the handwheel labeled to indicate the direction of rotation to open the gate. The direction of rotation to open shall be clockwise.

22. Furnish floor stands as required for operators and as specified above. The floor stand, anchors and accessories shall be supplied as part of the gate assembly by the gate manufacturer.
23. A weatherproof locking device shall be provided on the gate operator to prevent use of the manual operator and prevent access to the locally mounted electric controls. The device shall allow remote operation.
24. Furnish fracture-resistant clear polycarbonate stem covers complete with indicator markings to indicate gate position. Stem covers shall not discolor or become opaque for a minimum of five years after installation. The top of the stem cover shall be closed. The bottom end of the stem cover shall be mounted in a housing or adapter plate for easy field mounting.
25. Enclosures shall be FM certified or UL certified and shall be provided with space heaters to prevent condensation.
26. Each operator shall be provided with its own electrical controls housed in a NEMA 4 enclosure (unless otherwise shown) which shall be part of the operator. For outdoor installation, the controls shall be completely factory wired to the motor, limit switches and torque switch such that the only field wiring connection required, shall be for power supply and signal. All field wiring shall be to terminal strips.
27. Electrical operators arranged for open-close operation shall open and close the gate between the limit switch settings in response to a local or remote signal. The controls shall consist of a combination lockable circuit breaker and reversing starter with control power transformers. Control power shall be 110 Volt. A Open-Stop-Close pushbutton station shall be furnished and mounted as an integral part of the controls. A lockable Hand-Off-Auto selector switch shall also be provided to allow response to a remote Open-Stop-Close control. In addition to the mechanical position indicator, two indicating lights, one green and one red, shall be furnished. The lights shall be wired such that the green light shall be illuminated when the gate is fully closed, the red light shall be illuminated when the gate is fully open and both lights shall be illuminated when the gate is in any intermediate position. The power supply to the gate operator shall be ½ HP, 480 Volts, 3 Phase, 60 Hz.
28. Electrical operators arranged for modulating control shall provide raise and lower control in response to a 4-20 mADC remote signal, utilizing a completely solid state modulating control.
29. The operator shall utilize a 480 VAC, 3 Phase, reversing motor controlled by a solid state reversing starter to position the gate. Overshoot of the operator shall be controlled by pulsing the motor once the gate position approaches the desired position to decelerate the motor speed.
30. The controller shall compare the incoming 4-20 mADC signal with an internal position feedback signal generated by a mechanical potentiometer connected to the gate stem drive, and shall drive the operator to match these signals. The controller shall have an adjustable dead band to determine the difference between the reference signal and position signal at which the operator will readjust position.
31. The controller shall incorporate adjustments for span, zero, gain, and dead band. Power supply shall be 480 Volts, 3 Phase, 60 Hz. A control power transformer for 110 Volt, single phase control power shall be provided.
32. A Hand-Off-Automatic selector switch and a pushbutton Open-Stop-Close selector shall be provided as an integral part of the controls.
33. The gate shall remain in its last position on loss of power.
34. The electric operators shall be designed for operation of a rising stem gate.

K. Lifting Nut:

1. Material: Brass.
2. Furnish grease fitting.
3. Furnish polymer bearing pads above and below lifting nut.

L. Lifting Stem:

Material: The stem shall be of Type 316 stainless steel for the entire length, the metal having a tensile strength of not less than 60,000 psi. The stem shall have sufficient diameter at the base of the thread to lift the weight of the gate, offset the resistance of the gate to the maximum unbalanced head and fully allow for starting impact. The stem shall transmit in compression at least two times the rated output of the crank operated floor stand with a 40-lb effort on the crank. Stems of more than one section shall be joined by stainless steel couplings pinned and bolted to the stems. All threaded and keyed couplings of the same size shall be interchangeable. The gates shall be provided with adjustable bronze stop collars on the stem to prevent over closing of the gate. Minimum diameter of 1-1/2-in designed to withstand at least twice the rated output of the operator. The slenderness ratio ( $l/r$ ) shall be less than 200.

Stem guides shall be provided as recommended by the manufacturer. Stem guide shall be high nickel content cast iron, bronze bushed, mounted in a high nickel content cast iron bracket. It shall be adjustable in two directions and spaced at sufficient intervals to adequately support the stem. This spacing shall not exceed 10-ft.

1. Configuration:
  - a. Rising.
  - b. Removable.
2. Thread:
  - a. Machine cut threads, Acme type, double lead.
  - b. Cut threads are not acceptable.
3. Diameter: 1-1/8 inch
4. Fully lubricated.
5. Maximum Number of Turns: 16 per foot of travel.
6. Stem Covers: Provide rising stem gates with clear polycarbonate covers which shall not discolor or become opaque for a minimum of 5 years after installation, top, capped, vented, and of a length to allow full travel of gate. The bottom end of the stem cover shall be mounted in a housing or adapter plate for easy field mounting. Stem covers shall be complete with indicator markings to indicate gate position.

## 2.3 FINISHES

- A. Stainless-Steel Surfaces: Mill finish.

## 2.4 ACCESSORIES

- A. Hardware: Type 316 stainless steel, and shall conform to ASTM A193/A194 and F593/F594 except as otherwise specified herein. All necessary attaching bolts and anchor bolts shall be Type 316 stainless steel and shall be furnished by the slide gate manufacturer.
- B. Nameplates: Each slide gate shall have the manufacturer's name, address and product identification on a nameplate securely affixed to the gate.

## 2.5 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assemblies.
- C. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
  - 1. Specified shop tests are not required for Work performed by approved fabricator.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017300 and 017700 "Execution" and "Closeout Requirements" for requirements for installation examination.
- B. Verify that facilities are ready to receive slide gates.

### 3.2 PREPARATION

- A. Section 017300 and 017700 "Execution" and "Closeout Requirements" for requirements for installation preparation.
- B. Clean surfaces according to manufacturer's instructions.

### 3.3 INSTALLATION

- A. Install slide gates according to manufacturer's instructions.
- B. Ensure that products are installed plumb, true, and free of warp or twist.
- C. Locate operators to avoid interference with handrails and other Work.
- D. The installation of all gates shall be under the supervision of a representative of the manufacturer furnishing the gates. Furnish the services of a factory representative for [one] day,

who has complete knowledge of the proper installation, startup and operation of the cast iron slide gates, to inspect the final installation and supervise a test of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or Contractor's installation, additional service shall be provided at no cost to the Owner.

E. Guides:

1. Surface and Flange Mounted:

- a. Install guides with expansion anchors.
- b. Position guides at elevation as indicated on Drawings.

2. Recessed:

- a. Cut slot in concrete to receive guides.
- b. Position guides at elevation as indicated on Drawings.
- c. Grout guides in place according to manufacturer's instructions.

F. Sealant:

1. Apply 1/8-inchthick layer of elastomeric sealant to back of frame.
2. Tighten nuts snug until sealant begins to flow beyond frame.
3. Remove excess sealant.
4. Cure sealant for minimum seven days.
5. Tighten nuts to their final positions.

G. Lubricants: Provide oil and grease as required for initial operation.

### 3.4 FIELD QUALITY CONTROL

A. Section 014000 "Quality Requirements" for requirements for inspecting and testing.

B. Section 017300 and 017700 "Execution" and "Closeout Requirements" for requirements for testing, adjusting, and balancing.

C. Inspection:

1. Verify alignment of gate and components.
2. Verify that gate operates smoothly and does not bind or scrape.

D. Testing:

1. Comply with AWWA C561.
2. Leakage: Not exceeding 0.1 gpm/ft. of seating perimeter under 20 feet of seating head.
3. After installation, all slide gates shall be field tested to ensure that all items of equipment are in compliance with the Specifications, including the leakage requirements.
4. In the event that any unit fails to meet the above requirements, the necessary changes shall be made, and the unit retested. If the unit remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory unit at no cost to the Owner.



- E. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than four days over separate weeks on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.
- F. Equipment Acceptance:
  - 1. Adjust, repair, modify, or replace components failing to perform as specified and re-inspect.
  - 2. Make final adjustments to equipment under direction of manufacturer's representative.
- G. Furnish physical checkout and installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.
- H. Submit the equipment manufacturer's Certificate of Field Testing.
- I. Submit the equipment manufacturer's Certificate of Functional Testing.

### 3.5 ADJUSTING

- A. Section 017300 - Execution: Requirements for starting and adjusting.
- B. Adjust slide gates to provide smooth operation.

### 3.6 DEMONSTRATION

- A. Section 017900 "Demonstration and Training" for requirements for demonstration and training.
- B. Demonstrate equipment operation, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 400559.23



## SECTION 400567 - PRESSURE-REGULATING VALVES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Pressure-reducing valves.
- 2. Pressure-sustaining valves.

- B. Related Requirements:

- 1. Section 099000 "Painting" for coating and touchup of shop-primed surfaces with primer.
- 2. Section 400507 "Hangers and Supports for Process Piping" for anchors and supports.
- 3. Section 400551 "Process Valves."

#### 1.3 COORDINATION

- A. Section 013100 "Project Management and Coordination" for requirements for coordination.
- B. Coordinate with installation of process piping and equipment connections as specified in other Sections and as indicated on Drawings.

#### 1.4 SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.
- B. Comply with Section 400551 "Process Valves."
- C. Product Data: Submit manufacturer catalog information.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer Instructions: Submit special procedures and setting dimensions.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- G. Qualifications Statement:

1. Submit qualifications for manufacturer.

H. American Iron and Steel (AIS): Submit certification indicating compliance with AIS requirements.

#### 1.5 CLOSEOUT SUBMITTALS

A. Section 017000 “Execution and Closeout Requirements” for requirements for submittals.

B. Project Record Documents: Record actual locations of pressure-regulating valves.

#### 1.6 QUALITY ASSURANCE

A. Perform Work according to plant standards.

#### 1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 “Product Requirements” for requirements for transporting, handling, storing, and protecting products.

B. Section 400551 “Process Valves.”

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Store materials according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.

3. Provide additional protection according to manufacturer instructions.

#### 1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

#### 1.10 WARRANTY

- A. Section 017000 "Execution and Closeout Requirements" for requirements for warranties.
- B. Furnish five-year manufacturer's warranty for atmospheric vacuum breaker backflow preventers.
- C. Cavitation Damage: Warrant that valves will not suffer cavitation damage within a five-year period from date of installation when exposed to specified operating conditions.

### PART 2 - PRODUCTS

#### 2.1 PRESSURE-REDUCING VALVES

- A. Manufacturers:
  1. CLA-VAL Automatic Control Valves, Newport Beach, CA; GA Industries Inc., Cranberry Township, PA; Ross Valves, Troy, NY; Bermad Waterworks, Australia <.
  2. Substitutions: Not permitted.
- B. Description:
  1. Normally closed valves to maintain constant downstream pressure regardless of changing flow rate or varying inlet pressure , and to prevent backflow.
  2. Type: Pilot operated .
  3. Furnish V-ports for pressure control at low flows.
  4. Indicator Rod: Attached to piston for visual position indication.
- C. End Connections to match associated piping system
- D. Performance and Design Criteria:
  1. Flow Rate:
    - a. Maximum: 100 gpm
    - b. Minimum: 0 gpm
  2. Upstream Pressure:
    - a. Maximum: 150 psig
    - b. Minimum: 0 psig
  3. Set Point Downstream Pressure:
    - a. Range: Field adjustable from near zero to 110 percent of maximum.

E. Materials:

1. Body: Bronze, ASTM B62.
2. Disc and Diaphragm:
  - a. Buna-N rubber.
  - b. Disc Retainer and Diaphragm Washer: Bronze.
3. Trim: Stainless steel.
4. Stem, Nut, and Spring: Stainless steel.
5. Packing: PTFE.
6. Control Piping: Brass with stainless-steel wetted trim.

F. Interior Coating: Coat cast-iron and ductile-iron surfaces with epoxy coating according to AWWA C550.

G. Accessories:

1. Inlet/Outlet Pressure Gauges

## 2.2 THERMOPLASTIC PRESSURE-REDUCING VALVES

A. Manufacturers:

1. Plast-O-Matic, Cedar Grove, NJ, or equal.
2. Substitutions: Not permitted.

B. Description:

1. Normally open valves to maintain constant downstream pressure regardless of changing flow rate or varying inlet pressure.
2. Type: One-piece construction; Spring-operated.
3. Diaphragm seal isolating spring chamber.

C. End Connections:

1. Solvent Welded.

D. Performance and Design Criteria:

1. Flow Rate:
  - a. Maximum: 100 gpm
  - b. Minimum: 0 gpm
2. Upstream Pressure:
  - a. Maximum: 150 psig
  - b. Minimum: 0 psig

E. Materials:

1. Body: CPVC.
2. Seals: As required for service.
3. Stem, Nut, and Spring: Stainless steel.

2.3 PRESSURE-SUSTAINING VALVES –

A. Manufacturers:

1. CLA-VAL Automatic Control Valves, Newport Beach, CA; GA Industries Inc., Cranberry Township, PA; Ross Valves, Troy, NY; Bermad Waterworks, Australia <.
2. Substitutions: Not permitted.

B. Description:

1. Valve opens on increasing upstream pressure and closes on decrease in upstream pressure to maintain minimum set-point upstream pressure regardless of changing flow rate or varying downstream pressure.
2. Type: Pilot operated [with solenoid shut-off valve]..
3. Furnish V-ports for pressure control at low flows.
4. Indicator Rod: Attached to piston for visual position indication.

C. End Connections to match associated piping system and Drawings

D. Performance and Design Criteria:

1. Flow Rate:
  - a. Maximum: 100 gpm.
  - b. Minimum: 0 gpm.
2. Downstream Pressure:
  - a. Maximum: 150 psig.
  - b. Minimum: 0 psig.
3. Set-Point Upstream Pressure:
  - a. Range: Field adjustable from near zero to 110 percent.

E. Materials:

1. Body: Cast iron, ASTM A126, Class B.
2. Disc and Diaphragm:
  - a. Buna-N rubber or as required.
  - b. Disc Retainer and Diaphragm Washer: Bronze
3. Trim: Stainless steel.
4. Stem, Nut, and Spring: Stainless steel.
5. Packing: PTFE.

6. Control Piping: Brass with stainless-steel wetted trim.
- F. Interior Coating: Coat cast-iron and ductile-iron surfaces with epoxy coating according to AWWA C550.
- G. Accessories:
  1. Drain to atmosphere
  2. Inlet/Outlet Pressure Gauges

## 2.4 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.
- C. Certificate of Compliance:
  1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
  2. Specified shop tests are not required for Work performed by approved manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017000 "Execution and Closeout Requirements" for requirements for installation examination.
- B. Verify that field dimensions are as indicated on Drawings.
- C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.

### 3.2 PREPARATION

- A. Section 017000 "Execution and Closeout Requirements" for requirements for installation preparation.
- B. Thoroughly clean end connections before installation.
- C. Close pipe and equipment openings with caps or plugs during installation.
- D. Cleaning: Clean surfaces to remove foreign substances.



### 3.3 INSTALLATION

- A. According to manufacturer instructions and local code requirements.
- B. Install with nameplate and test cock accessible.

### 3.4 FIELD QUALITY CONTROL

- A. Section 014000 “Quality Requirements’ for requirements for inspecting and testing.
- B. After installation, inspect for interferences and proper supports.
- C. Testing:
  - 1. Hydrostatic: Test each assembled valve, except control piping, hydrostatically at 1-1/2 times rated working pressure for minimum five minutes.
  - 2. Leakage:
    - a. Test each valve for leakage at rated working pressure against closed valve.
    - b. Test Duration: Minimum 15 minutes.
    - c. Permitted Leakage: Zero.
  - 3. Perform functional test on each valve to verify specified performance.
- D. Repair damaged coatings with material equal to original coating.

### 3.5 CLEANING

- A. Section 017000 “Execution and Closeout Requirements” for requirements for cleaning.
- B. Keep interior of valves clean as installation progresses.

### 3.6 DEMONSTRATION

- A. Section 017000 “Execution and Closeout Requirements” for requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 400567



## SECTION 400589.13 - BASKET STRAINERS FOR PROCESS SERVICE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes: Basket Y-strainers.
- B. Related Requirements:
  - 1. Section 400507 "Hangers and Supports for Process Piping" for anchors and supports.
  - 2. Section 400531 "Thermoplastic Process Pipe."
  - 3. Section 462173 "Screenings Washer Compactor."

#### 1.3 COORDINATION

- A. Section 013100 "Project Management" for requirements for coordination.
- B. Coordinate Work of this Section with installation of process piping.

#### 1.4 SUBMITTALS

- A. Section 013300 "Submittal Procedures" for requirements for submittals.
- B. Product Data: Submit manufacturer catalog information.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions: Submit special procedures and setting dimensions.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- F. Qualifications Statement:
  - 1. Submit qualifications for manufacturer.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 "Execution and Closeout Requirements" for requirements for submittals.

- B. Project Record Documents: Record actual locations of basket strainers.

#### 1.6 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

#### 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' experience.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements" for requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
  - 3. Provide additional protection according to manufacturer instructions.

#### 1.9 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

#### 1.10 WARRANTY

- A. Section 017000 "Execution and Closeout Requirements" for requirements for warranties.
- B. Furnish five-year manufacturer's warranty for basket strainers.

## PART 2 - PRODUCTS

### 2.1 STRAINERS

#### A. Manufacturers:

1. Eaton, Moon Township, PA; Sure Flow Equipment Inc., Tonawanda, NY; Spirax Sarco, Blythewood, SC
2. Substitutions: Not permitted.

#### B. Description:

1. Comply with ASTM F1200.
2. Type: Y-Strainer Simplex Basket
3. Operation: Manual .
4. Port Size: as indicated on Drawings
5. Minimum Operating Pressure Rating: 40 psig at 60 degrees F.

#### C. Materials:

1. Body: Stainless steel.
2. Cover O-Ring: BUNA-N
3. Cap: stainless steel.

#### D. End Connections to match associated piping system:

#### E. Screen:

1. Material: Heavy gage, Type 316 stainless steel.
2. Size: minimum 3-inch
3. Perforated Openings: 1.5 mm
4. Free Area: Minimum three times pipe cross-sectional area.

#### F. Accessories:

1. Furnish threaded blow-off hole.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017000 "Execution and Closeout Requirements" for requirements for installation examination.
- B. Verify that field dimensions are as indicated on Drawings.
- C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.

### 3.2 PREPARATION

- A. Section 017000 “Execution and Closeout Requirements” for requirements for installation preparation.
- B. Thoroughly clean end connections before installation.
- C. Close pipe and equipment openings with caps or plugs during installation.
- D. Cleaning: Clean surfaces to remove foreign substances.

### 3.3 INSTALLATION

- A. According to manufacturer instructions.
- B. Install strainers in accessible locations for cleaning.

### 3.4 FIELD QUALITY CONTROL

- A. Section 017000 “Execution and Closeout Requirements” for requirements for testing, adjusting, and balancing.
- B. After installation, inspect for interferences and proper supports.
- C. Repair damaged coatings with material equal to original coating.

### 3.5 CLEANING

- A. Section 017000 “Execution and Closeout Requirements” for requirements for cleaning.
- B. Keep interior of basket strainers clean as installation progresses.

### 3.6 DEMONSTRATION

- A. Section 017000 “Execution and Closeout Requirements” for requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 400589.13

## SECTION 400593.23 – LOW-VOLTAGE MOTOR REQUIREMENTS FOR PROCESS 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. Section Includes:
  - 1. Single- and three-phase motors for application on process equipment provided under other Sections.
- B. The manufacturer of the driven equipment shall provide the associated motor.
- C. Related Requirements:
  - 1. Section 260526, “Grounding and Bonding for Electrical Systems”.
  - 2. Section 260553, “Identification for Electrical Systems”.
  - 3. Section 262923, “Variable-Frequency Motor Controllers”.
  - 4. Division 23, 40 and 46 for motorized equipment.

#### 1.3 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.
- B. VFD: Variable-frequency drive.

#### 1.4 SUBMITTALS

- A. Product Data: For each type and rating of motor indicated.
  - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
  - 2. Include nameplate data, compliance with specified standards, electrical ratings and characteristics, physical dimensions, frame size, weights, mechanical performance data, support points and the following:
    - a. Descriptive bulletins, including full description of insulation system.
    - b. Bearing design data.
    - c. Efficiency at  $\frac{1}{2}$ ,  $\frac{3}{4}$  and full load.
    - d. Power factor at  $\frac{1}{2}$ ,  $\frac{3}{4}$  and full load.
    - e. Conduit entry points and sizes.
    - f. Special features and accessories (i.e. space heaters, temperature detectors, etc.).

- g. Power factor correction capacitor rating and type (when required).
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Qualifications Statements:
  - 1. Submit qualifications for manufacturer and testing agency.

#### 1.5 QUALITY ASSURANCE

- A. Electric motors driving identical equipment shall be identical
- B. Motors shall be listed under UL recognized component file as applicable.
- C. Motor manufacturer to maintain a documented ISO 9001 quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.
- D. When electrically driven equipment differs from that indicated, adjust the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed.
- E. Testing Agency Qualifications: Member company of NETA or NICET.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Ship motor fully assembled, capable of being lifted in one piece. Comply with Section 016000, "Product Requirements" for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on site in manufacturer's original packaging and inspect for damage.
- C. Storage:
  - 1. Store materials according to manufacturer instructions.
  - 2. Energize motors furnished with space heaters to prevent condensation throughout the storage and construction period. Perform periodic motor insulation resistance tests per manufacturer's storage recommendations.
  - 3. For extended outdoor storage, remove motors from equipment and store separately.
  - 4. Maintain bearings during storage and construction period, and periodically rotate the motor shaft per manufacturer's storage recommendations.
  - 5. Lubricate per manufacturer's recommendations and inspect purged grease for water, rust, or other contaminants.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.



## 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of motors that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Three-years from date of Substantial Completion for inverter duty motors.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
  - 1. Nidec (US Motors)
  - 2. ABB (Baldor-Reliance)
  - 3. TECO-Westinghouse
  - 4. Toshiba
  - 5. WEG
  - 6. General Electric
  - 7. Or equal

### 2.2 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
- B. Comply with the latest revision of the following as applicable:
  - 1. NEMA MG 1, "Motors and Generators".
- C. Unless otherwise noted, all motors ½ through 100 horsepower shall be rated 230/460 Volt, three-phase, 60 Hertz A.C.; motors 125 horsepower and above shall be rated 460 Volt, three-phase, 60 Hertz; and motors below ½ horsepower shall be rated 115/230 Volt, single phase, 60 Hertz A.C.
- D. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- E. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- F. Horsepower rating: Size for operation within the full load nameplate rating without applying the service factor, throughout the full range of mechanical or hydraulic operating condition.
- G. Specific motor application data such as Hp, rpm, enclosure type, accessories, etc., are specified under the detailed driven mechanical equipment specification.

- H. Nameplates: Engrave or emboss on 316 stainless steel fastened to the motor frame with stainless steel screws or drive pins with information per NEMA MG 1.
- I. Space heater: Include 120-volt space heater for moisture control on all motors rated 50 horsepower and larger.
- J. Service Factor: 1.15 service factor on sine wave power and 1.0 service factor on VFD power in a 40 degrees C ambient, unless otherwise noted.
- K. Motors and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- L. Enclosures: Conform to one of the NEMA standard enclosure designs as specified under the detailed driven mechanical equipment specification. If no enclosure type is specified, provide TEFC (Totally Enclosed Fan Cooled) enclosures.
- M. Motors connected to VFDs: Inverter duty rated and comply with NEMA MG 1, Part 31. First or second torsional critical speed shall be outside the operating speed range for all VFD controlled motors.
- N. Three-phase motors:
  - 1. Description: NEMA MG 1, Design B, medium induction motor.
  - 2. Efficiency: Meet or exceed requirements for NEMA MG 1, Part 12 for Premium Efficient motors 1 HP and larger.
  - 3. Service Factor: 1.15.
  - 4. Multispeed Motors: Variable torque.
    - a. For motors with 2:1 speed ratio, consequent pole, single winding.
    - b. For motors with other than 2:1 speed ratio, separate winding for each speed.
  - 5. Rotor: Random-wound, squirrel cage.
  - 6. Code Letter Designation:
    - a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    - b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
  - 7. Accessories: Where specified herein, or under process mechanical specification.

## 2.3 THREE PHASE MOTOR CONSTRUCTION

- A. Enclosure and Frame:
  - 1. NEMA enclosure type as specified in the process equipment specification.
  - 2. NEMA frame for the associated horsepower.
  - 3. Motor frames: Cast iron or welded heavy plate steel construction, stiff enough to withstand the rotating forces and torques generated and designed to limit or avoid any undesirable harmonic resonances.
  - 4. Provide a threaded, forged steel, shouldered eyebolt blind tapped into the motor frame for lifting on all frames 254T and larger.

5. Condensate drain openings: Locate drain holes at the low points in the end brackets to allow removal of accumulated moisture from enclosures. Provide corrosion resistant, breather drain plugs for severe-duty motors.
  6. Hardware: Hex head, SAE Grade 5 or better, plated for corrosion protection.
  7. Nameplates: Engraved or embossed stainless steel plates fastened to the motor frame with stainless steel screws or drive pins. Clearly indicate all items of information listed in the applicable part of NEMA MG 1.
  8. Main terminal box: Fabricated steel or cast iron, sized per the NEC for number and size of conduit connections and conductor bending and terminations as indicated on the Drawings. Split box top to bottom with capability to rotate entry point to any quadrant. Provide gaskets between the box and motor frame and between box and its cover. Include ground lug for equipment grounding conductor termination.
  9. Bearing housings: Provide machined surfaces for attaching a magnet mounted accelerometer to monitor the motor vibration in the vertical, horizontal, and axial directions at each bearing housing.
  10. Frame grounding: provide motor frame grounding pad or threaded stud where supplemental grounding to frame is indicated on the drawings.
- B. Windings:
1. Copper
  2. Insulation rating: Class F.
  3. Temperature rise: Class B at 1.0 SF, Class F at 1.15 SF.
  4. Insulation: Non-hygroscopic, epoxy encapsulated windings for enclosure types WP I and WP II. Provide upgraded insulation by additional dips and bakes to increase moisture resistance for totally enclosed designs. Provide vacuum pressure impregnated (VPI) epoxy insulation for moisture resistance for outdoor motors.
  5. Provide chemical and humidity resistance insulation system when IEEE 841 motors are specified.
  6. Provide winding surge withstand capability per NEMA 1, Part 31 for VFD driven motors.
  7. Provide specified temperature sensing devices for VFD driven equipment. If not specified, provide a winding temperature detector per the accessories paragraph.
- C. Motor leads: Non-wicking type, minimum Class F temperature rating and permanently numbered for identification.
- D. Stator: Built up core using high grade, low loss silicon steel laminations keyed or dovetailed to the stator frame and securely held in place at each end.
- E. Rotor:
1. Forged or rolled steel shaft, machined, smooth finished, with sufficient strength for operation including 25 percent overspeed condition.
  2. Shaft end coordinated with driven equipment coupling.
  3. Entire assembly coated with protective coating.
  4. Inpro seals on both ends of the shaft to prevent grease leakage and entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest. Severe duty motors to have improved sealing per IEEE 841.
  5. Vertical Motor Shafts:

- a. Provide hollow shaft and P flange mounting to allow driven shaft to extend through provide for vertical pump applications.
  - b. Coupling for connecting the motor shaft to the driven shaft is located in the top of the motor.
  - c. Where solid shaft is provided couple the driven shaft below the P flange face.
6. Rotor Core:
- a. Solid, built-up stack of fully processed and coated, high-grade, low-loss silicon steel laminations.
  - b. Die cast aluminum or fabricated copper bars or their respective alloys.
  - c. Rotors on frames 213T and above to be keyed to shaft and rotating assembly dynamically balanced.
7. Rotor Assembly:
- a. Coated with corrosion resistant epoxy insulating varnish or other protective coating, thermally stable, statically and dynamically balanced.
  - b. Balance weights securely attached to the rotor resistance ring by welding or similar permanent method.
- F. Horizontal Bearings: roller type, sealed bearing.
1. Bearings: Anti-friction sealed bearing, vacuum-degassed steel ball or roller bearings, electric motor quality, designed for 45 degrees C maximum temperature rise. Metric size bearings are not acceptable.
  2. Life: L 10 life of 100,000 hours for direct coupled applications and 26,000 hours for belted applications based. IEEE 841 motors, L 10 life increased to 150,000 and 50,000 hours respectively.
  3. Shaft seals: Provide to prevent grease leakage and the entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest.
  4. Shaft currents: Provide mitigation per process equipment specification.
  5. Comply with ABMA and refer to process equipment specification for stricter or additional requirements.
- G. Vertical Bearings: per manufacturer, thrust type.
1. Bearings: Manufacturer's standard design, constructed with thrust bearings on top to allow inspection and/or replacement without requiring complete disassembly of motor, of type and size to satisfy thrust loading requirements.
  2. Life: Rated for an in-service L 10 life of 8800 hours, designed to support the weight of the rotor plus, if required, the weight of the rotating driven equipment parts and the hydraulic thrust created by the driven equipment, with a 40 degrees C maximum temperature rise. Metric bearings are not acceptable.
  3. Shaft seals: Provide to prevent grease leakage and the entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest.
  4. Shaft currents: Provide mitigation per process equipment specification.
  5. Comply with ABMA and refer to process equipment specification for stricter or additional requirements.

## 2.4 THREE PHASE MOTOR ACCESSORIES

- A. Space heaters: Silicone rubber strip type, accessible for inspection, rated 120 Volt, single phase, designed to prevent condensation inside the enclosure when the motor is idle, with leads brought out to a separate terminal box. Emboss the heater wattage and voltage on the motor nameplate.
- B. Winding temperature switch: Three embedded bi-metallic temperature thermostat switches with normally open or normally closed per process equipment specification and leads terminating in the main conduit box.
- C. Motor shaft currents: insulate the ODE bearing and provide a shaft grounding strap. Insulate bearing probes to prevent shorting out bearing insulation.
- D. Shaft grounding rings: maintenance free, circumferential micro fiber type, AEGIS™ SGR by electro Static Technology or equal to discharge shaft currents to ground.
- E. Encoder for vector drive motors: Provide encoder on opposite drive end to sense rotor speed and provide closed loop feedback (quadrature signal with line driver output) to a control device. Provide sufficient length of encoder cable to connect encoder to variable frequency controller.

## 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Motors 1/20 HP and Smaller: Shaded-pole type.
- D. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- E. Insulation: Class F or better, with Class B temperature rise of 80 degrees C above ambient, 1.15 service factor. Locked rotor current to be no greater than specified in NEMA MG 1, Design "N".
- F. Standard enclosure: Fully gasketed, totally-enclosed air over or fan cooled in conformance with NEMA MG 1.
- G. Washdown duty enclosure: Where motor is installed in wet or corrosive areas routinely exposed to washdowns, high humidity or caustic chemicals, provide stainless steel, paint free washdown

motors with Inpro bearing isolators, stainless steel T-type condensation drains, nitrile conduit box gasket, and corrosion resistant fans.

- H. Bearings: Sealed ball bearings permanently lubricated for 10 years normal use, furnished with shaft slinger.
- I. Class 1, Division 1 and 2 locations: Explosion proof, marked with a T3B temperature code label, and UL listed for use in Class 1, Division 1, Groups C & D, and Class II, Groups E, F, & G hazardous location. The temperature code marking to appear on the nameplate.

## 2.6 SOURCE QUALITY CONTROL

- A. Section 014000 “Quality Requirements” for requirements for testing, inspection, and analysis.
- B. Factory Testing: Prior to shipment perform manufacturer’s standard tests in accordance with NEMA MG 1 and IEEE 112.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Upon delivery of motor and prior to unloading, inspect equipment for damage.
- B. Comply with Article “Delivery, Storage, and Handling”.

### 3.2 INSTALLATION

- A. Prepare rigid foundation or mounting surface to minimize vibration and maintain alignment between motor and load shaft.
- B. Install the motors per manufacturer's installation instructions.
- C. Anchor motor base to load bearing surface with grade 5 steel bolts or better.
- D. Align the motor shaft with driven equipment according to manufacturer’s written instructions. Adjust axial position of motor frame with respect to load shaft.
- E. Accurately adjust flexible couplings for direct drive according to machine manufacturer’s guidelines. Check alignment to minimize vibrations. Coupling spacing shall be according to coupling manufacturer guidelines.
- F. Install motor branch circuit conduits and conductors in accordance with NEC and local code requirements. Connect motors to rigid conduit system by a short section of liquid-tight flexible conduit to isolate the conduit system from motor vibration. Where motors are installed outdoors, bring conduit into bottom of motor terminal box to avoid standing water at connection point.

- G. Terminate the motor leads as shown on the connection diagrams using products intended for vibration applications.
- H. Ground equipment according to Section 260526, "Grounding and Bonding for Electrical Systems."
- I. Tighten electrical connections and terminals according to manufacturers' published torque values.
- J. Install conduit and wiring between motor auxiliary devices and associated indicators, controllers and protective devices in accordance to installation drawings.
- K. Connect devices sensitive to electromagnetic interferes such as RTD's, thermistors, thermal protector switches, vibration sensors with shielded instrumentation wiring per installation drawings.
- L. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553, "Identification for Electrical Systems." Identify field-installed conductors, interconnecting wiring, and components.

### 3.4 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until motors are ready to be energized and placed into service.
- B. Lubrication and Shaft Rotation: Lubricate parts and rotate shaft periodically according to manufacturer's written instructions until motors are ready to be energized and placed into service.

### 3.5 FIELD QUALITY CONTROL

- A. Perform inspections and tests Inspect and test according to the Inspection and Test Procedures for Rotating Machinery state in NETA Acceptance Testing Specification paragraph 7.15.1. Options tests are not required unless called for within the process equipment specification.
- B. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Motors will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies the motor and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### 3.6 STARTUP AND ADJUSTMENT

- A. Complete installation and startup checks according to manufacturer's written instructions. Confirm motor is structurally, mechanically, and electrically ready for start-up. Checks include support system, vibration isolation, alignment, lubrication system, and cleanliness.
- B. Start-up motor in accordance with process equipment specification.
- C. Verify correct phase rotation at motor with driven equipment uncoupled. Correction for phase rotation to be made in the motor terminal box.
- D. Prepare inspection and test reports.

### 3.7 DEMONSTRATION / SYSTEM FUNCTION TESTS

- A. Run motor for system testing as required in motor controller and driven equipment specifications.
- B. Confirm correct operation of all protective and metering devices.
- C. Measure voltage and motor running current and evaluate relative to load conditions and nameplate full load amperes. Corrective action is required for any current imbalance 10 percent or greater.
- D. Prepare driven equipment system testing report. Include results of all tests and check made, meter readings and recordings, and summary adjustments made. Clearly identify any discrepancies and concerns.

END OF SECTION 400593.23



## SECTION 404113.13 - PROCESS PIPING ELECTRICAL RESISTANCE HEAT TRACING

### 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. Manufacturer to design and supply the entire electrical heat trace system, including the schematic arrangements, cable, junction boxes, thermostats and controls, and other equipment necessary to complete the system as shown on the Drawings and as specified herein.
- B. Heat tape and thermostatic controls and insulation and sheathing for the following to be provided by the CONTRACTOR:
  - 1. Concentrated scum piping to the screening and grit collection bins, as shown on the drawings. Provide heat tapes for the concentrated scum pump discharge piping and delivery point to maintain a minimum temperature of 110-degree F but not greater than 140-degree F maximum when energized. Provide insulation and heat tracing per requirements in Sections 404213 and as specified in this Section. Provide heat tracing suitable for Class I, Division II hazardous locations.
  - 2. Makeup Air Unit Hot Water Supply (HPS) and Hot Water Return (HWR), as shown on the drawings.
- C. Section Includes:
  - 1. Self-regulating cables.
  - 2. Heat-tracing controls.
- D. Related Requirements:
  - 1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for execution requirements for electrical connections to equipment specified by this Section.
  - 2. Section 404213 - Process Piping Insulation: Insulation and jacketing of process piping.

#### 1.3 DEFINITIONS

- A. Self-Regulating Index (SRI): The rate of change of power output in Watts per degree F, as measured between the temperatures of 50 and 100 degrees F.

#### 1.4 COORDINATION

- A. Coordinate Work of this Section with installation of process piping, and installation of piping insulation.

#### 1.5 PREINSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing Work of this Section.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information for system materials and component equipment, including thermal properties, electrical characteristics, and connection requirements.
- B. Shop Drawings:
  - 1. Indicate system materials and component equipment.
  - 2. Submit wiring and control diagrams, installation and anchoring requirements, fasteners, and other details.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- C. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- E. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.
- F. Qualifications Statement:
  - 1. Submit qualifications for manufacturer.

#### 1.8 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of piping and appurtenances receiving heat tracing, and locations of source power and controls.

#### 1.9 QUALITY ASSURANCE

- A. Perform Work according to plant standards.

- B. Maintain two copies of each standard affecting Work of this Section on Site.

#### 1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

#### 1.11 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.

#### 1.12 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

#### 1.13 WARRANTY

- A. Furnish five-year manufacturer's warranty for heat tracing and components.

### PART 2 - PRODUCTS

#### 2.1 SELF-REGULATING CABLE

- A. Manufacturers:
  - 1. Raychem/Pentair Thermal/Chemelex,
  - 2. Chromalox
  - 3. Thermon
  - 4. Or approved equal.
- B. Description:
  - 1. Bus Wires:

- a. Quantity: Two.
  - b. Orientation: Parallel.
  - c. Material: Nickel-coated copper.
  - d. Minimum Size: #16 AWG.
2. Heating Element: Self-regulating polymeric core.
  3. Jacketing:
    - a. Description: Tinned copper braid with resistance less than cable bus wire resistance.
    - b. Comply with ASTM B193.
    - c. Insulating Jacket: Polyolefin.
  4. Cable Temperature Identification Number (T-Rating):
    - a. T6, without use of thermostats.
    - b. Comply with NEC.
  5. Output:
    - a. As indicated on Drawings.
    - b. Minimum 5 W/ft..
- C. Performance and Design Criteria:
1. Power Output: Vary relative to temperature of surface of pipe or appurtenance.
  2. Cable can be cut to length on Site.
  3. Minimum SRI:
    - a. Cable Rating 5 W/ft.: 0.060 W/degrees F.
    - b. Cable Rating 8 W/ft.: 0.074 W/degrees F.
- D. Operation:
1. Electrical Characteristics:
    - a. As specified in Section 260519 - Low-Voltage Electrical Power Conductors and Cables.
    - b. Voltage: 120V, single phase, 60 Hz.
    - c. Maximum Circuit Breaker Size: 20A.
    - d. Ground-Fault Protection Device: Set at 30 mA, with nominal 100-ms response time, to protect each circuit.
- E. Accessories:
1. Splicing connectors.
  2. End terminations.
  3. T-connectors.
  4. Power termination kits.

## 2.2 HEAT-TRACING CONTROLS

### A. Single Thermostat (for Makeup Air Unit HWS/HWR):

1. Description: Stainless-steel remote bulb with 6-foot capillary encased in flexible stainless-steel armor.
2. Housing:
  - a. FM approved.
  - b. Rating: NEMA 250 Type 4X.
3. Set-Point Range: 35 to 235 degrees F.

### B. Explosion-Proof Thermostat (for Concentrated Scum):

1. Description: 6-foot capillary bulb encased in armored sheathing.
2. Housing:
  - a. Material: Cast aluminum.
  - b. Comply with NEC hazardous location requirements based on Site conditions.
3. Set-Point Range: 35 to 235 degrees F.

## 2.3 SOURCE QUALITY CONTROL

### A. Testing:

1. Retain at least 75 percent of rated power after 20 years of operation at maximum published continuous exposure temperature.
2. Retain at least 90 percent of rated power after 1,000 hours of operation at maximum published intermittent exposure temperature.
3. Cable Dielectric Test: Passing 2.5 kV dielectric test for one minute according to ASTM D2633 after undergoing a 0.5 kg-m impact.
4. Before shipment, demonstrate cable insulation resistance of 20 megohms minimum bus to braid using a 2,500-V dc megger, and demonstrate tolerance for one minute at voltage equal to twice rated plus 1,000 V applied bus to braid.
5. Thermal Runaway:
  - a. Ensure that cable produces less than 0.5 W/ft. when energized and heated to 350 degrees F for 30 minutes.
  - b. After testing and reenergizing, demonstrate that cable does not have an increasing power output leading to thermal runaway.

### B. Owner Inspection:

1. Make completed heat-tracing assembly available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

### C. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

D. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that surfaces of pipes, valves, and fittings are clean and dry.
- B. Verify that piping has been inspected and is ready for insulation.

#### 3.2 INSTALLATION

- A. Install heat tracing before insulation is installed.
- B. Install equipment according to manufacturer instructions.
- C. If required, spiral heat-trace cable around piping to obtain proper heating per length of piping.
- D. Do not overlay cable over cable.
- E. Cover installed heating cable with thermal insulation and waterproof jacketing as soon as possible.
- F. Affix following label to exterior of thermal insulation every 15 feet and readily visible from ground level: CAUTION: ELECTRIC HEAT TRACING.

#### 3.3 FIELD QUALITY CONTROL

- A. After installation, inspect for proper operation.
- B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 8 hours on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- C. Equipment Acceptance:
  1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
  2. Make final adjustments to equipment under direction of manufacturer's representative.

- D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

#### 3.4 ADJUSTING

- A. Check control functions and adjust as required.

#### 3.5 DEMONSTRATION

- A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 404113.13





## SECTION 404213 - PROCESS PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Process piping insulation.
- 2. Jacketing.
- 3. Accessories.

- B. Related Requirements:

- 1. Section 099100 "Painting" for execution requirements for painting insulation jackets and coverings as specified by this Section.
- 1. Section 400513 "Common Work Results" for penetrations of assemblies with fire-resistance rating greater than one hour.
- 2. Section 400551 "Process Valves."
- 3. Section 400531 "Thermoplastic Process Pipe."

#### 1.3 ACTION SUBMITTALS

- A. See Section 013300 "Submittal Procedures" for submittals requirements.
- B. Product Data: Product description, thermal characteristics, list of materials, and thickness for each service and location.
- C. Samples: Submit one sample of representative size, illustrating each insulation type.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Products meet or exceed specified requirements.
- B. Manufacturer's Instructions: Manufacturer's published literature indicating recommended installation procedures.
- C. Qualifications Statements:
  - 1. Qualifications for manufacturer and applicator.
  - 2. Manufacturer's approval of applicator.

#### 1.5 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame-spread index of 25 and maximum smoke-developed index not exceeding 50, according to ASTM E84.
- B. Comply with ASTM C585 for inner and outer diameters of pipe insulation.
- C. Factory-fabricated fitting covers according to ASTM C450.
- D. Perform Work according to standards set by authorities having jurisdiction.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 016000 "Product Requirements" for transporting, handling, storing, and protecting products requirements.
- B. Accept materials on-Site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Inspection: Accept insulation on-Site in manufacturer's packaging. Inspect for damage.
- D. Store insulation according to manufacturer's instructions.
- E. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.

#### 1.8 AMBIENT CONDITIONS

- A. See Section 015000 "Temporary Facilities and Controls" for ambient condition control facilities for product storage and installation requirements.
- B. Install insulation only when ambient temperature and humidity conditions are within ranges as recommended by manufacturer.
- C. Maintain recommended temperature and humidity before, during, and after installation for minimum of 24 hours.

## 1.9 EXISTING CONDITIONS

### A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

## 1.10 WARRANTY

- A. See Sections 017300 and 017700 "Execution" and "Closeout Requirements" for warranties requirements.
- B. Furnish three-year manufacturer's warranty for human-made fiber.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

#### A. Glass Fiber and Mineral Fiber Insulation:

1. Manufacturers: Manville Corp.; Certain-Teed; Owens-Corning Fiberglass; or equal.
2. Furnish materials according standards set by authorities having jurisdiction.

#### B. Closed-Cell Elastomeric Insulation:

1. Manufacturers: Armacell or equal
2. Furnish materials according to standards set by authorities having jurisdiction.

### 2.2 PIPE INSULATION

#### A. Molded glass fiber.

1. Comply with ASTM C547 and ASTM C795 for application on austenitic stainless steel.
2. Thermal Conductivity: 0.23 Btu-in./h-ft.-deg. F at 75 degrees F.
3. Operating Temperature Range: Zero to 300 degrees F (Minus 18 to 454 degrees C).
4. Vapor Barrier Jacket: Factory-applied, reinforced foil kraft with self-sealing adhesive joints.
  - a. Comply with ASTM C1136, Type I.
  - b. Jacket Temperature Limits: Minus 20 to 150 degrees F.

### 2.3 PIPE INSULATION JACKETS

#### A. PVC Plastic Pipe Jacket: One-piece, molded-type fitting covers and sheet material.

1. Color: Off-white.
2. Comply with ASTM D1785.

3. Thickness: 15 mils.
4. Connections: Brush-on welding adhesive.

## 2.4 PIPE INSULATION ACCESSORIES

- A. Covering Adhesive Mastic: Compatible with insulation.
- B. Piping 1-1/2-Inch Diameter and Smaller:
  1. Galvanized-steel insulation protection shield.
  2. Comply with MSS SP-69, Type 40.
  3. Length: Based on pipe size and insulation thickness.
- C. Piping 2-Inch Diameter and Larger:
  1. Wood insulation saddle, hard maple.
  2. Inserts Length: Not less than 6 inches.
  3. Thickness and Contour: Match adjoining insulation.
- D. Closed-Cell Elastomeric Insulation Pipe Hangers:
  1. Polyurethane insert with stainless-steel jacket single-piece construction and self-adhesive closure.
  2. Thickness: Match pipe insulation.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. See Section 017000 "Execution and Closeout Requirements" for installation examination requirements.
- B. Verify that piping and equipment has been tested before applying insulation materials.
- C. Verify that surfaces are clean and dry, with foreign material removed.

### 3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Fire-Rated Penetrations:
  1. Continue insulation through penetrations of building assemblies or portions of assemblies having fire-resistance rating of one hour or less.
  2. Provide intumescent firestopping when continuing insulation through assembly.
  3. Finish at supports, protrusions, and interruptions.
  4. Refer to Section 400513 "Common Work Results" for Process Piping for penetrations of assemblies with fire-resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Jacketing:
  - a. Furnish factory-applied or field-applied vapor-retarder jackets.
  - b. Secure factory-applied jackets with pressure-sensitive adhesive with self-sealing longitudinal laps and butt strips.
  - c. Secure field-applied jackets with outward-clinch expanding staples, and seal stapled penetrations with vapor-retarder mastic.
3. Fittings, Joints, and Valves:
  - a. Insulate with molded insulation of like material and thickness as adjacent pipe.
  - b. Finish removable PVC fitting covers.

D. Glass-Fiber Board Insulation:

1. Apply insulation close to equipment by grooving, scoring, and beveling insulation.
2. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface; on cold equipment, use vapor-retarder cement.
4. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems Less than 140 degrees F

1. Factory-applied or field-applied standard jackets, secured with outward-clinch expanding staples or pressure-sensitive adhesive system on standard factory-applied jacket and butt strips, or both.
2. Fittings, Joints, and Valves:
  - a. Insulate with like material and thickness as adjoining pipe.
  - b. Removable PVC fitting covers.
3. Do not insulate unions and flanges at equipment; bevel and seal ends of insulation at such locations.

F. Hot Piping Systems Greater than 140 degrees

1. Factory-applied or field-applied standard jackets, securing with outward-clinch expanding staples or pressure-sensitive adhesive system on standard factory-applied jacket and butt strips, or both.
2. Fittings, Joints, and Valves:
  - a. Insulate with like material and thickness as adjoining pipe.
  - b. Removable PVC fitting covers.
3. Insulate flanges and unions at equipment.

G. Inserts and Shields:

1. Piping 1-1/2 inch Diameter and Smaller: Install galvanized-steel shield between pipe hanger and insulation.
2. Piping 2-inch Diameter and Larger:
  - a. Install insert between support shield and piping, and under finish jacket.
  - b. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
  - c. Insert Material: Compression-resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller-Type Pipe Hangers: Install stainless steel shield between roller and inserts.

H. Closed-Cell Elastomeric Insulation:

1. Push insulation onto piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. If application requires multiple layers, apply with staggered joints.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

I. High-Temperature Pipe Insulation:

1. Install in multiple layers to meet scheduled thickness.
2. Attach each layer with bands, securing first layer with bands before installing next layer.
3. Stagger joints between layers.
4. Finish with canvas jacket sized for finish painting.

J. Piping Exposed in Equipment Rooms or Finished Spaces Less than 10 feet above Finished Floor or platform: Finish with PVC jacket and fitting covers.

K. Heat-Traced Piping Interior to Building:

1. Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe.
2. Size large enough to enclose pipe and heat tracing.

L. Prepare pipe insulation for finish painting as specified in Section 099000 "Painting and Coating."

### 3.3 ATTACHMENTS

A. Process Piping Insulation Schedule:

1. Scum Piping (SC):
  - a. Thickness: 1 inch
2. Hot County Owned Water (HOT-COW):
  - a. Thickness: 1 inch

3. Hot Plant Effluent Water (HOT-PEW):
  - a. Thickness: 1 inch

END OF SECTION 404213





## SECTION 406100 - PROCESS CONTROL AND ENTERPRISE MANAGEMENT SYSTEMS GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes procurement of the services of a Process Control System Supplier (PCSS) to furnish and install all materials, equipment, labor and services, required to achieve a fully integrated and operational system as specified herein, in “Related Requirements” under this Article, and in related drawings, except for those services and materials specifically noted.
- B. Demolish I/O in existing DCU panel per Appendix A – Arlington PTB Input-Output (IO) Demolition. All signals with strikethrough to be demolished. Perform this work subject to constraints in Section 018100 “Maintenance of Plant Operations (MOPO)”.
- C. Provide instruments, and control panel modifications in the Preliminary Treatment Building for a scum treatment system and new screening capabilities. Interface the vendor-provided systems and new instruments and devices with the DCU of the existing Process Control System (PCS). Perform modifications to existing panels as needed to achieve a fully-functional system.
- D. Work does not include the following:
  - 1. PLC Programming and Human Machine Interface (HMI) graphics development.
  - 2. Supply of vendor packaged systems.
- E. Include auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, whether indicated on the Drawings or not.
- F. All equipment and installations shall satisfy applicable Federal, State and local codes. Refer to Electrical drawings for area classifications for Class and /Division ratings.
- G. Use the equipment, instrument, and loop numbering scheme indicated on the Drawings and in the specifications in the development of the submittals. Do not deviate from or modify the numbering scheme.

#### 1.3 DEFINITIONS

- A. PCSS: Process Control System Supplier.

- B. AESS: Applications Engineering System Supplier. The Owner will perform the role of AESS.
- C. MOPO: Maintenance of Plant Operations.
- D. "Section 406XXX - Sections for Computer System Hardware": The XXX in the number indicates all spec sections starting with the first 3 numbers (indicating a category described in the accompanying text) are included in the reference.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Arlington County Water Pollution Control Plant (WPCP).
- B. Conduct a project kickoff coordination meeting within two weeks after submitting the Project Plan. The purpose of the meeting is to discuss the PCSS's Project Plan, to summarize the PCSS's understanding of the project; discuss any proposed substitutions or alternatives; schedule testing and delivery deadline dates; provide a forum to coordinate hardware and software related issues; and request any additional information required from the Owner. The meeting will last up to 4 hours.
- C. Conduct a submittal review coordination meeting after the Hardware, Panel Drawing, and Loop Drawing Submittal package has been reviewed by the Engineer and returned to the PCSS. The purpose of this meeting is to review comments made on the submittal package; to refine scheduled deadline dates; coordinate equipment installation activities; and provide a forum for any further required coordination between the PCSS and AESS. The meeting will last up to 4 hours.
- D. Attendance at MOPO meeting.
- E. Bi-Weekly on site or conference call coordination meetings with Engineer, Contractor, Vendors, and AESS as required prior to any field start-up or activity testing begins.
- F. Schedule the mandatory coordination meetings as described herein. Hold the meetings at the Owner's designated location and include attendance by the Owner, the Engineer, the Contractor, the PCSS's Project Engineer, and the AESS Project Engineer, if applicable. Other Division 406XXX specifications may require additional meetings. Prepare and distribute an agenda for this meeting a minimum of one week before the scheduled meeting date. Schedule the meeting for a minimum of one week before the requested meeting date.

#### 1.5 ACTION SUBMITTALS

- A. Product Data:
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Refer to Section 407000 "Instrumentation for Process Systems."

**B. Shop Drawings:**

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of equipment, control panels, and instrumentation as specified herein.
4. Include diagrams for power, signal, and control wiring.

**C. Qualifications Submittal:**

1. For non-listed PCSS', submit, within 30 calendar days after Notice to Proceed, detailed information on staff and organization to indicate compliance with the Quality Assurance requirements of this Section. The Qualifications submittal is required to be submitted and approved before any further submittals will be accepted. PCSS will be rejected if they fail to meet the minimum requirements. The Qualifications Submittal shall, as a minimum, contain the following:
  - a. Copies of ISA CCST Level 1 certificates for all field technicians or resumes demonstrating field experience.
  - b. Notarized statement from the firm's financial institution demonstrating ability for the firm to meet the obligations necessary for the performance of the work.
  - c. Copy of UL-508 certificate for panel fabrication facilities.
  - d. Project references for water or wastewater projects as defined in the "Quality Assurance" paragraphs.
  - e. Documentation to demonstrate the ability to complete this project including: resumes of key staff, financial capacities, details on engineering, design, fabrication, and field service capacity, and location of staff responsible for responding to the site within four hours to resolve startup issues.

**D. Project Plan, Deviation List, and Schedule Submittal:**

1. Submit, within 45 calendar days after Notice to Proceed, a Project plan. The Project Plan is required to be submitted and approved before further submittals are accepted. The Project Plan shall contain the following:
  - a. Overview of the proposed control system describing the understanding of the project work, a preliminary system architecture drawing, interfaces to other systems, schedule, sequencing, startup, and coordination. Include a general discussion of startup, replacement of screening and scum concentration equipment, methods of maintaining plant operations during system transition and other tasks as required by these specifications.
  - b. Project personnel and organization including the PCSS project manager, project engineer, and lead project technicians. Include resumes of each these individuals and specify in writing their commitment to this project. These do not need to be submitted again if already submitted in the Qualification submittal.
  - c. Sample formats of the shop drawings to be submitted and in conformance with the requirements of the Specifications. At a minimum include samples of panel fabrication drawings, loop drawings, and I/O wiring diagrams.

2. Clearly define exceptions to the Specifications or Drawings in a Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. If no exceptions are taken to the specifications or drawings the PCSS shall make a statement as such. If there is no statement by the PCSS, then it is acknowledged that no exceptions are taken.
3. The PCSS must coordinate their work with the General Contractor's overall schedule and is responsible for ensuring a schedule is included in this submittal that incorporates all PCSS milestones including but not limited to the following:
  - a. Schedule for all subsequent project submittals. Include the time required for Contractor submittal preparation, Engineer's review time, and a minimum of two complete review cycles.
  - b. Proposed dates for all project coordination meetings.
  - c. Hardware purchasing, fabrication, and assembly (following approval of related submittals).
  - d. Shipment of instrument and control system equipment.
  - e. Installation of instrument and control system equipment.
  - f. Testing: Schedule for all testing.
  - g. Schedule for system cutover, startup, and/or going on-line for each major system.
  - h. Schedule for all training including submittal and approval of O&M manuals, factory training, and site training.
  - i. Arrange project schedule to accommodate requirements to develop, test, troubleshoot, and train Owner on PLC and HMI systems.
    - 1) Completion of Training on PLC and HMI equipment: Twenty-one calendar days after successful completion and acceptance by the Engineer of PCSS's training.
4. Component and Wiring Identification and Tagging Plan:
  - a. All components provided by PCSS require a tag, label, or nameplate. Review specifications and provide a table indicating the tagging and labeling scheme used by the PCSS:
    - 1) Instruments.
    - 2) Panel Hardware.
    - 3) Wires and communication cables.
  - b. Provide detailed information so Engineer is able to review the following characteristics for each type of tag, label, or nameplate for the different types of components provided above:
    - 1) Size or range of size of the tag, label or nameplate.
    - 2) Font style.
    - 3) Material.
    - 4) Color(s).

**E. Input/Output (I/O) List Submittal:**

1. Submit, within 60 days after Notice to Proceed, a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
2. Base I/O list on the P&ID's, the Drawings, the design I/O list (if included), and requirements in the Specifications.
3. Submit I/O list in both a Microsoft Excel readable electronic file format and an 8-1/2 inch by 11-inch hard copy.
4. Show all active and spare I/O points on I/O list. Add points to accommodate spare I/O as required in the specifications.
5. Arrange I/O list such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet shall include the following information:
  - a. TAG NUMBER(S): As indicated on the Drawings, the identifier assigned to a device that performs a function in the control system. As part of this information, break out the loop number of the tag for sorting by loop.
  - b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
  - c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
  - d. PHYSICAL POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
  - e. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO - Pulse Output.
  - f. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
  - g. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
  - h. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
  - i. P&ID - the P&ID or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the P&IDs.
  - j. EXISTING or NEW I/O POINT: Indicate if point is existing (E) or new (N).
  - k. CONDITION OF EXISTING SIGNAL: Note condition of existing I/O signals as functional (F) if working properly or if not functioning (NF) with issue described.
6. Sort I/O list in order by:
  - a. Physical location.
  - b. I/O Type.
  - c. Loop Number.
  - d. Device Tag.
7. Once the I/O list is approved, the PLC I/O addresses shall not be modified without approval by the Engineer.

**F. MOPO and Sequencing Submittal**

1. The PCSS shall assist in the development of the Contractor's MOPO and sequencing submittal to ensure an orderly transition from the existing control system to the new control system. See Section 018100 "Maintenance of Plant Operations (MOPO)" for specific requirements. The PCSS may not proceed with the submission of any hardware and software submittals until this submittal is approved
2. Include step-by-step procedures and required durations to install, commission, and place into operation the new screening and scum concentration equipment. The procedures shall include a minimum 4 week notification to the Owner for any system alterations that affect operation of the facility including parties involved at each phase.
3. Provide a spreadsheet indicating point-by-point transition of all I/O points.
4. Provide network architecture phasing plans showing the condition of the new and existing network at each phase of construction.

G. Field Instruments Submittal:

1. Refer to the Instruments section for submittal requirements.
2. Panel Layout Drawings: Submit Drawings for all panels specified. Draw panel assembly and elevation drawings to scale and detail all equipment in or on the panel. Develop 11" x 17" drawings. At a minimum, the panel drawings shall include the following:
  - a. A legend sheet clearly indicating all symbols used on drawings and with voltage, color and size of each wire clearly indicated and in accordance with requirements of Section 406733 "Panel Wiring."
  - b. Interior and exterior panel elevation drawings to scale.
  - c. Nameplate schedule.
  - d. Conduit access locations.
  - e. Panel construction details.
  - f. Cabinet assembly and layout drawings to scale. Assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. Cross reference bill of material to the assembly drawing so that a non-technical person can readily identify all components of the assembly by manufacturer and model number.
  - g. Fabrication and painting specifications including color (or color samples).
  - h. Construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
  - i. Submit evidence that all control panels are constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application are accomplished at the fabrication location or by field inspection by UL inspectors. Costs associated with obtaining the UL seal and any inspections will be borne by Contractor.
3. Wiring Diagrams Submittal:
  - a. Where direct hardwired interfaces exist between the PCSS control panels and vendor provided control panels furnished under other Divisions, Contractor shall provide to PCSS approved submittals in order for PCSS to provide complete wiring diagrams showing all wiring connections in the I/O system. This includes but is not limited to terminal block numbering, relay contact information,

instruments, equipment, and control panel names. Include these drawings in Final O&M submittal. Leaving this information blank on Final Documentation drawings is not acceptable.

- b. Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. If ISA Loop Wiring Diagrams are specified below, equipment external to the control panel and related external connections do not need to be shown on the Panel Wiring Diagrams. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. Diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the PCSS. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the PCSS and approved by the Engineer. Number I/O wiring with rack number, slot number, and point number. Clearly identify two-wire and four-wire equipment note power sources. Submit final wire numbering scheme. Develop 11" x 17" panel drawings .
- c. ISA Loop Wiring Diagrams: Required.

#### H. Testing Plan Submittals:

1. Refer to Section 40 61 21 "Process Control System Testing" for specific testing submittal requirements.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For any named PCSS, submit a statement on company letterhead indicating that the requirements in the "Quality Assurance" paragraph below are met by the firm.
- B. Product Test Reports: Refer to individual instrument, component or hardware specifications for specific requirements.
- C. Evaluation Reports: Refer to individual instrument, component or hardware specifications for specific requirements.

### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For all PCSS supplied hardware to include in operation and maintenance manuals.
  1. Submit in accordance with Section 01 78 23 "Operation and Maintenance Data".
  2. The operations and maintenance manuals shall, at a minimum, contain the following information:
    - a. Table of Contents:
      - 1) Provide a Table of Contents for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.

- b. Instrument and Equipment Lists:
- 1) Develop the following lists in Microsoft Excel format:
    - a) An instrument list or spreadsheet for all instruments supplied including tag number, description, specification section, manufacturer, model number, calibrated range, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
    - b) An equipment list or spreadsheet for all non-instrument devices supplied listing description, specification section, manufacturer, model number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
- c. Equipment Operations and Maintenance Information:
- 1) Provide ISA-TR20.00.01-2001(updated in 2004-2006) data sheets for all field instruments. For non-field instrumentation devices, provide a cover page for each device, piece of equipment, and OEM software that lists date, specification number, product name, manufacturer, model number, Location(s), and power required. Preferred format for the cover page is ISA-TR20.00.01-2001(updated in 2004-2006), general data sheet; however, other formats will be acceptable provided they contain all required information.
  - 2) Provide new documentation written specifically for this project or modified standard vendor documentation of all Vendor O&M for each device, piece of equipment, or OEM software. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. Neatly cross out all portions that do not apply. Remove groups of pages or sections that do not apply at all to the specific model supplied.
  - 3) Provide the record documentation of the completed test forms with sign-offs as specified in Section 40 61 21 "Process Control System Testing."
  - 4) Include instrument/equipment calibration and configuration forms developed as specified in Section 40 61 21 "Process Control System Testing."
- d. As-Built Drawings:
- 1) Complete as-built drawings, including all drawings and diagrams specified in this section under the "Submittals" section. These drawings shall include all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the PCSS. Provide electronic files for all drawings produced. Produce drawings in AutoCAD ".dwg" format and in Adobe Acrobat format. Provide drawings using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.
  - 2) As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Errors



in or modifications to the system resulting from the Factory and/or Incorporate Functional Acceptance Tests in this documentation.

B. Software and Firmware Operational Documentation:

a. Electronic O&M Information:

- 1) In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals and data sheets, along with any software back-up of configuration files, on CD-ROM. Supply electronic documents in Adobe Acrobat format.
  - 2) Provide electronic files for all custom-developed manuals including training manuals. Supply text in both Microsoft Office format and Adobe Acrobat format.
  - 3) Provide electronic files for all drawings produced. Produce drawings in AutoCAD ".dwg" format and in Adobe Acrobat format. Provide drawings using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.
  - 4) Back up each computer system hardware device onto CD-ROM after Substantial Completion and turn over to the Owner.
  - 5) If specified in the training section, provide digital copies of all training videos. Format videos in a format that is readable by standard DVD players and by standard PC DVD drives. Format with a minimum resolution of 800 by 600 pixels and include sound.
2. The cover and edge of each volume shall contain the information as specified in Section 01 78 23 "Operation and Maintenance Data."

1.8 MAINTENANCE MATERIAL SUBMITTAL

- A. Furnish extra materials from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Refer to individual specification Sections 407113 "Magnetic Flow Meters" through 407859 "Power Supplies" for spare equipment requirements and provide one comprehensive spare parts submittal for project.
  2. Submit unit and total costs for the additional spare items specified or recommended for each subsystem.
- B. Pack all spare parts in individual cartons and labeled with indelible markings clearly indicating component(s) inside. Supply complete ordering information paperwork including manufacturer's contact information (address and phone number), part name, part number, equipment name and tag number(s) for which the part is to be used (if applicable) with the required spare parts. Deliver spare parts and store in a location directed by the Owner or Engineer.

## 1.9 QUALITY ASSURANCE

- A. The PCSS is responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.
- B. Process Control System Supplier (PCSS): a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. For the purposes of this Specification Section, a "systems integrator" complies with all of the following criteria:
1. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. Key personnel shall hold ISA CCST Level 1 certification or have a minimum of 10 years of verifiable plant startup experience. Key personnel shall include, as a minimum, the lead field technician.
  2. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Define successful completion as a finished project completed on time, without any outstanding claims or litigation involving the PCSS. Provide potential references for projects where the PCSS's contract was of similar size to this project.
  3. Has been actively engaged in the type of work specified in this Section for a minimum of five years.
- C. The PCSS shall maintain a permanent, fully staffed and equipped service facility within 200 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the PCSS will be capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within 4 hours of notification throughout project and up to two months after startup completion.
- D. Listed suppliers will not be required to submit a qualifications proposal (see "Informational Submittals"). Contractors interested in listing an equal to the above listed suppliers shall submit PCSS' qualifications for review and approval as specified herein.
- E. Select one of the following PCSS:
1. Sherwood Logan and Associates  
2140 Renard Court  
Annapolis, MD 21401  
(410) 841-6810  
Contact: Bob Fairweather
  2. CIM Automation Systems  
1054B South High Street  
Harrisonburg, VA 22801  
(540) 442-6270  
Contact: Bob Link
  3. Systems East, Inc.  
30 Basil Sawyer Drive  
Hampton, VA 23666

(757) 766-8400

Contact: Buck McLaughlin

4. or equal.

- F. Being listed in this specification does not relieve any potential PCSS from meeting the qualifications specified in this Section.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 016000 "Product Requirements" for delivery, storage, and handling requirements.

#### 1.11 FIELD CONDITIONS

- A. Elevation: Design equipment to operate at the project ground elevation.

- B. Temperature:

1. Equipment located in indoor locations shall operate between 10 to 35 C degrees ambient minimum.
2. Storage temperatures shall range from 0 to 50 C degrees ambient minimum.
3. Furnish additional cooling or heating if required by the equipment as specified herein.
4. Relative Humidity. Air-conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between 5 to 100 percent relative, condensing humidity.

#### 1.12 WARRANTY

1. Warranty Period: 3 years from date of Substantial Completion unless noted otherwise in individual specification sections.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Electrical Requirements for Control System:

1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Provide regulators and power supplies required for compliance with the above between power supply and interconnected instrument loop. Supply constant voltage transformers where equipment requires voltage regulation.
2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise.

3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.
4. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.
5. Wire switches and/or signals indicating an alarm, failure or upset condition in a fail-safe manner as indicated on the instrument list. A fail-safe condition is when an open circuit generates an alarm state (i.e. contact opens).
6. Provide UL approved materials and equipment whenever such approved equipment and materials are available.
7. Furnish and design all equipment and construct so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.
8. Surge protection requirements for control system power, signal, and communication lines are specified in Section 407856 "Isolators, Intrinsically Safe Barriers, and Surge Suppressors."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine control panels and instrumentation before installation. Reject control panels and instrumentation that are wet, moisture damaged, or mold damaged.
- C. Examine walls, floors, roofs, and columns for suitable conditions where control panels or instrumentation will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 GENERAL INSTALLATION

- A. Install continuous shield on each process instrumentation cable from source to destination and ground at only one ground point for each shield.

### 3.3 IDENTIFICATION

- A. Provide identification system for all PCSS provided hardware, instrumentation, and communication cabling. Provide details as specified in "Project Plan".

### 3.4 FIELD QUALITY CONTROL

- A. Refer to Section 014000 "Quality Requirements" for preparation of test and inspection reports.

### 3.5 STARTUP SERVICE

- A. Refer to Section 406121 “Process Control System Testing.”
- B. Refer to Section 406126 “Process Control System Training.”
- C. Weekly on-site coordination meetings with Engineer, Contractor, and AESS as required during active construction period.

END OF SECTION 406100



Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
POTOMAC INTERC. CHAMB. FLOW - FORWARD FLOW	DI	1	0	0											
POTOMAC INTERC. CHAMB. FLOW - FORWARD FLOW	DI	1	0	1											
POTOMAC INTERC. CHAMB. SUMP PUMP - NOT IN REMOTE	DI	1	0	2											
POTOMAC INTERC. CHAMB. SUMP PUMP - TROUBLE	DI	1	0	3											
POTOMAC INTERC. CHAMB. SUMP PUMP - RUN	DI	1	0	4											
BAR SCREEN NO. 1 INFLUENT GATE NOT IN REMOTE	DI	1	0	5											
BAR SCREEN NO. 1 NOT IN REMOTE	DI	1	0	6											
BAR SCREEN NO. 1 RUNNING FORWARD	DI	1	0	7											
BAR SCREEN NO. 1 RUNNING REVERSE	DI	1	0	8											
BAR SCREEN NO. 1 E-STOP	DI	1	0	9											
BAR SCREEN NO. 1 FAIL	DI	1	0	10											
GRIT CHAMBER MIXER NO. 1 RUN	DI	1	0	11											
GRIT CHAMBER MIXER NO. 1 MOTOR OVERLOAD	DI	1	0	12											
SCREW CONVEYOR NO. 1 NOT IN REMOTE	DI	1	0	13											
SCREW CONVEYOR NO. 1 RUN	DI	1	0	14											
SCREW CONVEYOR NO. 1 FAIL	DI	1	0	15											
SCREENING COMPACTOR NO. 1 NOT IN REMOTE	DI	1	1	0											
SCREENING COMPACTOR NO. 1 RUN	DI	1	1	1											
SCREENING COMPACTOR NO. 1 FAIL	DI	1	1	2											
SPARE	DI	1	1	3											
SPARE	DI	1	1	4											
SPARE	DI	1	1	5											
GRIT CLASSIFIER NO. 1 NOT IN REMOTE	DI	1	1	6											
GRIT CLASSIFIER NO. 1 RUN	DI	1	1	7											
GRIT CLASSIFIER NO. 1 FAIL	DI	1	1	8											
BAR SCREEN NO. 2 INFLUENT GATE NOT IN REMOTE	DI	1	1	9											
BAR SCREEN NO. 2 NOT IN REMOTE	DI	1	1	10											
BAR SCREEN NO. 2 RUNNING FORWARD	DI	1	1	11											
BAR SCREEN NO. 2 RUNNING REVERSE	DI	1	1	12											
BAR SCREEN NO. 2 E-STOP	DI	1	1	13											
BAR SCREEN NO. 2 FAIL	DI	1	1	14											
PTB INFLUENT CHAMBER LEVEL HI HI FLOAT	DI	1	1	15											
GRIT CHAMBER MIXER NO. 2 RUN	DI	1	2	0											
GRIT CHAMBER MIXER NO. 2 MOTOR OVERLOAD	DI	1	2	1											
SCREW CONVEYOR NO. 2 NOT IN REMOTE	DI	1	2	2											
SCREW CONVEYOR NO. 2 RUN	DI	1	2	3											
SCREW CONVEYOR NO. 2 FAIL	DI	1	2	4											
SCREENING COMPACTOR NO. 2 NOT IN REMOTE	DI	1	2	5											
SCREENING COMPACTOR NO. 2 RUN	DI	1	2	6											
SCREENING COMPACTOR NO. 2 FAIL	DI	1	2	7											
SPARE	DI	1	2	8											
SPARE	DI	1	2	9											
SPARE	DI	1	2	10											
GRIT CLASSIFIER NO. 2 NOT IN REMOTE	DI	1	2	11											
GRIT CLASSIFIER NO. 2 RUN	DI	1	2	12											
GRIT CLASSIFIER NO. 2 FAIL	DI	1	2	13											
SPARE	DI	1	2	14											
SPARE	DI	1	2	15											
BAR SCREEN NO. 3 INFLUENT GATE NOT IN REMOTE	DI	1	3	0											
BAR SCREEN NO. 3 NOT IN REMOTE	DI	1	3	1											
BAR SCREEN NO. 3 RUNNING FORWARD	DI	1	3	2											
BAR SCREEN NO. 3 RUNNING REVERSE	DI	1	3	3											
BAR SCREEN NO. 3 E-STOP	DI	1	3	4											
BAR SCREEN NO. 3 FAIL	DI	1	3	5											
GRIT CHAMBER MIXER NO. 3 RUN	DI	1	3	6											
GRIT CHAMBER MIXER NO. 3 MOTOR OVERLOAD	DI	1	3	7											
SCREW CONVEYOR NO. 3 NOT IN REMOTE	DI	1	3	8											
SCREW CONVEYOR NO. 3 RUN	DI	1	3	9											
SCREW CONVEYOR NO. 3 FAIL	DI	1	3	10											
SPARE	DI	1	3	11											
SPARE	DI	1	3	12											
SPARE	DI	1	3	13											
GRIT CHAMBER MIXER NO. 4 RUN	DI	1	3	14											
GRIT CHAMBER MIXER NO. 4 MOTOR OVERLOAD	DI	1	3	15											

Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
SCUM CONCENTRATOR NOT IN REMOTE	DI	1	4	0											
SCUM CONCENTRATOR RUN	DI	1	4	1											
SCUM CONCENTRATOR ZERO SPD.	DI	1	4	2											
SCUM CONCENTRATOR HIGH TORQUE	DI	1	4	3											
SCREW CONVEYOR NO. 4 NOT IN REMOTE	DI	1	4	4											
SCREW CONVEYOR NO. 4 RUN	DI	1	4	5											
SCREW CONVEYOR NO. 4 FAIL	DI	1	4	6											
SCUM PUMP NO. 1 NOT IN REMOTE	DI	1	4	7											
SCUM PUMP NO. 1 RUN	DI	1	4	8											
SCUM PUMP NO. 1 OVERLOAD	DI	1	4	9											
SCUM PUMP NO. 1 HIGH DISCHARGE PRESS.	DI	1	4	10											
SPARE	DI	1	4	11											
SPARE	DI	1	4	12											
SPARE	DI	1	4	13											
SPARE	DI	1	4	14											
SPARE	DI	1	4	15											
SCUM PUMP NO. 2 NOT IN REMOTE	DI	1	5	0											
SCUM PUMP NO. 2 RUN	DI	1	5	1											
SCUM PUMP NO. 2 OVERLOAD	DI	1	5	2											
SCUM PUMP NO. 2 HIGH DISCHARGE PRESS.	DI	1	5	3											
SPARE	DI	1	5	4											
SPARE	DI	1	5	5											
SPARE	DI	1	5	6											
SPARE	DI	1	5	7											
SPARE	DI	1	5	8											
SPARE	DI	1	5	9											
HYPOCHL. FD PMP NO. 1 RUN	DI	1	5	10											
HYPOCHL. FD PMP NO. 1 ALARM	DI	1	5	11											
HYPOCHL. FD PMP NO. 1 DISCH. PRESS. HIGH	DI	1	5	12											
HYPOCHL. FD PMP NO. 1 NOT IN REMOTE	DI	1	5	13											
SPARE	DI	1	5	14											
SPARE	DI	1	5	15											
SPARE	DI	1	6	0											
SPARE	DI	1	6	1											
SPARE	DI	1	6	2											
HYPOCHL. FD PMP NO. 2 RUN	DI	1	6	3											
HYPOCHL. FD PMP NO. 2 ALARM	DI	1	6	4											
HYPOCHL. FD PMP NO. 2 DISCH. PRESS. HIGH	DI	1	6	5											
HYPOCHL. FD PMP NO. 2 NOT IN REMOTE	DI	1	6	6											
SEAL WATER PUMP NO. 1 NOT IN AUTO	DI	1	6	7											
SEAL WATER PUMP NO. 1 RUN	DI	1	6	8											
SEAL WATER PUMP NO. 1 LOW PRESS.	DI	1	6	9											
BASEMENT NORTH SUMP PUMP NO. 1 HIGH LEVEL	DI	1	6	10											
BASEMENT NORTH SUMP PUMP NO. 1 NOT IN AUTO	DI	1	6	11											
BASEMENT NORTH SUMP PUMP NO. 1 RUN	DI	1	6	12											
BASEMENT NORTH SUMP PUMP NO. 1 FAIL	DI	1	6	13											
SPARE	DI	1	6	14											
SPARE	DI	1	6	15											
SEAL WATER PUMP NO. 2 NOT IN AUTO	DI	1	7	0											
SEAL WATER PUMP NO. 2 RUN	DI	1	7	1											
SPARE	DI	1	7	2											
FLOOR AND DRAIN SUMP PUMP NO. 1 HIGH LEVEL	DI	1	7	3											
FLOOR AND DRAIN SUMP PUMP NO. 1 NOT IN AUTO	DI	1	7	4											
FLOOR AND DRAIN SUMP PUMP NO. 1 RUN	DI	1	7	5											
FLOOR AND DRAIN SUMP PUMP NO. 1 FAIL	DI	1	7	6											
CONCENTRATOR SUMP PUMP NO. 1 HIGH LEVEL	DI	1	7	7											
CONCENTRATOR SUMP PUMP NO. 1 NOT IN AUTO	DI	1	7	8											
CONCENTRATOR SUMP PUMP NO. 1 RUN	DI	1	7	9											
CONCENTRATOR SUMP PUMP NO. 1 FAIL	DI	1	7	10											
BASEMENT SOUTH SUMP PUMP NO. 1 HIGH LEVEL	DI	1	7	11											
BASEMENT SOUTH SUMP PUMP NO. 1 NOT IN AUTO	DI	1	7	12											
BASEMENT SOUTH SUMP PUMP NO. 1 RUN	DI	1	7	13											
BASEMENT SOUTH SUMP PUMP NO. 1 FAIL	DI	1	7	14											
SPARE	DI	1	7	15											



Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
SPARE	DI	1	8	0											
SPARE	DI	1	8	1											
SPARE	DI	1	8	2											
SPARE	DI	1	8	3											
CONCENTRATOR SUMP PUMP NO. 2 HIGH LEVEL	DI	1	8	4											
CONCENTRATOR SUMP PUMP NO. 2 NOT IN AUTO	DI	1	8	5											
CONCENTRATOR SUMP PUMP NO. 2 RUN	DI	1	8	6											
CONCENTRATOR SUMP PUMP NO. 2 FAIL	DI	1	8	7											
SPARE	DI	1	8	8											
BASEMENT NORTH SUMP PUMP NO. 2 NOT IN AUTO	DI	1	8	9											
BASEMENT NORTH SUMP PUMP NO. 2 RUN	DI	1	8	10											
BASEMENT NORTH SUMP PUMP NO. 2 FAIL	DI	1	8	11											
HIGH GAS ALARM	DI	1	8	12											
SUPPLY FAN_SF-4A_NOT IN AUTO	DI	1	8	13											
SUPPLY FAN_SF-4A_RUN_FAST	DI	1	8	14											
SUPPLY FAN_SF-4A_FAIL	DI	1	8	15											
SPARE	DI	1	9	0											
BASEMENT SOUTH SUMP PUMP NO. 2 NOT IN AUTO	DI	1	9	1											
BASEMENT SOUTH SUMP PUMP NO. 2 RUN	DI	1	9	2											
BASEMENT SOUTH SUMP PUMP NO. 2 FAIL	DI	1	9	3											
SUPPLY FAN_SF-4B NOT IN AUTO	DI	1	9	4											
SUPPLY FAN_SF-4B_RUN_FAST	DI	1	9	5											
SUPPLY FAN_SF-4B_FAIL	DI	1	9	6											
FOUL AIR FAN_FAF-1A NOT IN AUTO	DI	1	9	7											
FOUL AIR FAN_FAF-1A_RUN	DI	1	9	8											
FOUL AIR FAN_FAF-1A_FAST	DI	1	9	9											
FOUL AIR FAN_FAF-1A_FLOW_ALARM	DI	1	9	10											
FOUL AIR FAN_FAF-1A_FAIL	DI	1	9	11											
SPARE	DI	1	9	12											
SPARE	DI	1	9	13											
SUPPLY FAN_SF-4A_RUN_SLOW	DI	1	9	14											
SUPPLY FAN_SF-4B_RUN_SLOW	DI	1	9	15											
SPARE	DI	1	10	0											
SUPPLY FAN_SF-2 FAST	DI	1	10	1											
SUPPLY FAN_SF-2 SLOW	DI	1	10	2											
SUPPLY FAN_SF-2 FAIL	DI	1	10	3											
FOUL AIR FAN_FAF-1B NOT IN AUTO	DI	1	10	4											
FOUL AIR FAN_FAF-1B_RUN	DI	1	10	5											
FOUL AIR FAN_FAF-1B_FAST	DI	1	10	6											
FOUL AIR FAN_FAF-1B_FLOW_ALARM	DI	1	10	7											
FOUL AIR FAN_FAF-1B_FAIL	DI	1	10	8											
FOUL AIR FAN_FAF-1B TO ATMOSPHERE	DI	1	10	9											
FOUL AIR FAN_FAF-1B TO BUILDING	DI	1	10	10											
SPARE	DI	1	10	11											
FOUL AIR FAN_FAF-1A TO ATMOSPHERE	DI	1	10	12											
FOUL AIR FAN_FAF-1A TO BUILDING	DI	1	10	13											
SPARE	DI	1	10	14											
SPARE	DI	1	10	15											
SPARE	DI	1	11	0											
SUPPLY FAN_SF-3 FAST	DI	1	11	1											
SUPPLY FAN_SF-3 SLOW	DI	1	11	2											
SUPPLY FAN_SF-3 FAIL	DI	1	11	3											
SUMP PUMP NO. 1 LEVEL HIHI	DI	1	11	4											
SUMP PUMP NO. 1 MOTOR RUNNING	DI	1	11	5											
SUMP PUMP NO. 1 TROUBLE	DI	1	11	6											
SPARE	DI	1	11	7											
POTOMAC INTERCEPTOR FLOW METER CHAMBER LEVEL HIGH	DI	1	11	8											
CLARIFIER TANK DRAIN PUMP 1 RUN STATUS	DI	1	11	9											
CLARIFIER TANK DRAIN PUMP 1 FAIL	DI	1	11	10											
CLARIFIER TANK DRAIN PUMP 2 RUN STATUS	DI	1	11	11											
CLARIFIER TANK DRAIN PUMP 2 FAIL	DI	1	11	12											
ODOR CONTROL SUMP 2 LEVEL HIHI	DI	1	11	13											
ODOR CONTROL SUMP 2 MOTOR RUNNING	DI	1	11	14											
ODOR CONTROL SUMP 2 TROUBLE	DI	1	11	15											

Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
CROSS COLLECTOR NO. 1 NOT IN REMOTE	DI	1	12	0											
CROSS COLLECTOR NO. 1 RUN	DI	1	12	1											
CROSS COLLECTOR NO. 1 FAIL	DI	1	12	2											
CROSS COLLECTOR NO. 1 HIGH TORQUE	DI	1	12	3											
LONG COLLECTOR NO. 1 NOT IN REMOTE	DI	1	12	4											
LONG COLLECTOR NO. 1 RUN	DI	1	12	5											
LONG COLLECTOR NO. 1 FAIL	DI	1	12	6											
LONG COLLECTOR NO. 1 HIGH TORQUE	DI	1	12	7											
SPARE	DI	1	12	8											
SPARE	DI	1	12	9											
PRIMARY SLUDGE PUMP NO. 1 NOT IN AUTO	DI	1	12	10											
PRIMARY SLUDGE PUMP NO. 1 RUN	DI	1	12	11											
PRIMARY SLUDGE PUMP NO. 1 VFD FAIL	DI	1	12	12											
PRIMARY SLUDGE PUMP NO. 1 CHECK FAIL	DI	1	12	13											
SPARE	DI	1	12	14											
SPARE	DI	1	12	15											
CROSS COLLECTOR NO. 2 NOT IN REMOTE	DI	1	13	0											
CROSS COLLECTOR NO. 2 RUN	DI	1	13	1											
CROSS COLLECTOR NO. 2 FAIL	DI	1	13	2											
CROSS COLLECTOR NO. 2 HIGH TORQUE	DI	1	13	3											
LONG COLLECTOR NO. 2 NOT IN REMOTE	DI	1	13	4											
LONG COLLECTOR NO. 2 RUN	DI	1	13	5											
LONG COLLECTOR NO. 2 FAIL	DI	1	13	6											
LONG COLLECTOR NO. 2 HIGH TORQUE	DI	1	13	7											
SPARE	DI	1	13	8											
SPARE	DI	1	13	9											
PRIMARY SLUDGE PUMP NO. 2 NOT IN AUTO	DI	1	13	10											
PRIMARY SLUDGE PUMP NO. 2 RUN	DI	1	13	11											
PRIMARY SLUDGE PUMP NO. 2 VFD FAIL	DI	1	13	12											
PRIMARY SLUDGE PUMP NO. 2 CHECK FAIL	DI	1	13	13											
SPARE	DI	1	13	14											
SPARE	DI	1	13	15											
CROSS COLLECTOR NO. 3 NOT IN REMOTE	DI	1	14	0											
CROSS COLLECTOR NO. 3 RUN	DI	1	14	1											
CROSS COLLECTOR NO. 3 FAIL	DI	1	14	2											
CROSS COLLECTOR NO. 3 HIGH TORQUE	DI	1	14	3											
LONG COLLECTOR NO. 3 NOT IN REMOTE	DI	1	14	4											
LONG COLLECTOR NO. 3 RUN	DI	1	14	5											
LONG COLLECTOR NO. 3 FAIL	DI	1	14	6											
LONG COLLECTOR NO. 3 HIGH TORQUE	DI	1	14	7											
SPARE	DI	1	14	8											
SPARE	DI	1	14	9											
PRIMARY SLUDGE PUMP NO. 3 NOT IN AUTO	DI	1	14	10											
PRIMARY SLUDGE PUMP NO. 3 RUN	DI	1	14	11											
PRIMARY SLUDGE PUMP NO. 3 VFD FAIL	DI	1	14	12											
PRIMARY SLUDGE PUMP NO. 3 CHECK FAIL	DI	1	14	13											
SPARE	DI	1	14	14											
SPARE	DI	1	14	15											
CROSS COLLECTOR NO. 4 NOT IN REMOTE	DI	1	15	0											
CROSS COLLECTOR NO. 4 RUN	DI	1	15	1											
CROSS COLLECTOR NO. 4 FAIL	DI	1	15	2											
CROSS COLLECTOR NO. 4 HIGH TORQUE	DI	1	15	3											
LONG COLLECTOR NO. 4 NOT IN REMOTE	DI	1	15	4											
LONG COLLECTOR NO. 4 RUN	DI	1	15	5											
LONG COLLECTOR NO. 4 FAIL	DI	1	15	6											
LONG COLLECTOR NO. 4 HIGH TORQUE	DI	1	15	7											
SPARE	DI	1	15	8											
SPARE	DI	1	15	9											
PRIMARY SLUDGE PUMP NO. 4 NOT IN AUTO	DI	1	15	10											
PRIMARY SLUDGE PUMP NO. 4 RUN	DI	1	15	11											
PRIMARY SLUDGE PUMP NO. 4 VFD FAIL	DI	1	15	12											
PRIMARY SLUDGE PUMP NO. 4 CHECK FAIL	DI	1	15	13											
SPARE	DI	1	15	14											
SPARE	DI	1	15	15											

Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
CROSS COLLECTOR NO. 5 NOT IN REMOTE	DI	2	0	0											
CROSS COLLECTOR NO. 5 RUN	DI	2	0	1											
CROSS COLLECTOR NO. 5 FAIL	DI	2	0	2											
CROSS COLLECTOR NO. 5 HIGH TORQUE	DI	2	0	3											
LONG COLLECTOR NO. 5 NOT IN REMOTE	DI	2	0	4											
LONG COLLECTOR NO. 5 RUN	DI	2	0	5											
LONG COLLECTOR NO. 5 FAIL	DI	2	0	6											
LONG COLLECTOR NO. 5 HIGH TORQUE	DI	2	0	7											
SPARE	DI	2	0	8											
SPARE	DI	2	0	9											
PRIMARY SLUDGE PUMP NO. 5 NOT IN AUTO	DI	2	0	10											
PRIMARY SLUDGE PUMP NO. 5 RUN	DI	2	0	11											
PRIMARY SLUDGE PUMP NO. 5 VFD FAIL	DI	2	0	12											
PRIMARY SLUDGE PUMP NO. 5 CHECK FAIL	DI	2	0	13											
SPARE	DI	2	0	14											
SPARE	DI	2	0	15											
CROSS COLLECTOR NO. 6 NOT IN REMOTE	DI	2	1	0											
CROSS COLLECTOR NO. 6 RUN	DI	2	1	1											
CROSS COLLECTOR NO. 6 FAIL	DI	2	1	2											
CROSS COLLECTOR NO. 6 HIGH TORQUE	DI	2	1	3											
LONG COLLECTOR NO. 6 NOT IN REMOTE	DI	2	1	4											
LONG COLLECTOR NO. 6 RUN	DI	2	1	5											
LONG COLLECTOR NO. 6 FAIL	DI	2	1	6											
LONG COLLECTOR NO. 6 HIGH TORQUE	DI	2	1	7											
SPARE	DI	2	1	8											
SPARE	DI	2	1	9											
PRIMARY SLUDGE PUMP NO. 6 NOT IN AUTO	DI	2	1	10											
PRIMARY SLUDGE PUMP NO. 6 RUN	DI	2	1	11											
PRIMARY SLUDGE PUMP NO. 6 VFD FAIL	DI	2	1	12											
PRIMARY SLUDGE PUMP NO. 6 CHECK FAIL	DI	2	1	13											
SPARE	DI	2	1	14											
SPARE	DI	2	1	15											
CROSS COLLECTOR NO. 7 NOT IN REMOTE	DI	2	2	0											
CROSS COLLECTOR NO. 7 RUN	DI	2	2	1											
CROSS COLLECTOR NO. 7 FAIL	DI	2	2	2											
CROSS COLLECTOR NO. 7 HIGH TORQUE	DI	2	2	3											
LONG COLLECTOR NO. 7 NOT IN REMOTE	DI	2	2	4											
LONG COLLECTOR NO. 7 RUN	DI	2	2	5											
LONG COLLECTOR NO. 7 FAIL	DI	2	2	6											
LONG COLLECTOR NO. 7 HIGH TORQUE	DI	2	2	7											
SPARE	DI	2	2	8											
SPARE	DI	2	2	9											
PRIMARY SLUDGE PUMP NO. 7 NOT IN AUTO	DI	2	2	10											
PRIMARY SLUDGE PUMP NO. 7 RUN	DI	2	2	11											
PRIMARY SLUDGE PUMP NO. 7 VFD FAIL	DI	2	2	12											
PRIMARY SLUDGE PUMP NO. 7 CHECK FAIL	DI	2	2	13											
SPARE	DI	2	2	14											
SPARE	DI	2	2	15											
CROSS COLLECTOR NO. 8 NOT IN REMOTE	DI	2	3	0											
CROSS COLLECTOR NO. 8 RUN	DI	2	3	1											
CROSS COLLECTOR NO. 8 FAIL	DI	2	3	2											
CROSS COLLECTOR NO. 8 HIGH TORQUE	DI	2	3	3											
LONG COLLECTOR NO. 8 NOT IN REMOTE	DI	2	3	4											
LONG COLLECTOR NO. 8 RUN	DI	2	3	5											
LONG COLLECTOR NO. 8 FAIL	DI	2	3	6											
LONG COLLECTOR NO. 8 HIGH TORQUE	DI	2	3	7											
SPARE	DI	2	3	8											
SPARE	DI	2	3	9											
PRIMARY SLUDGE PUMP NO. 8 NOT IN AUTO	DI	2	3	10											
PRIMARY SLUDGE PUMP NO. 8 RUN	DI	2	3	11											
PRIMARY SLUDGE PUMP NO. 8 VFD FAIL	DI	2	3	12											
PRIMARY SLUDGE PUMP NO. 8 CHECK FAIL	DI	2	3	13											
SPARE	DI	2	3	14											
SPARE	DI	2	3	15											

Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
DCU-PTB POWER MONITOR (ON)	DI	2	4	0											
DCU-PTB PANEL HIGH TEMPERATURE ALARM	DI	2	4	1											
DCU-PTB UPS ON BATTERY POWER ALARM	DI	2	4	2											
DCU-PTB UPS BATTERY LOW ALARM	DI	2	4	3											
DCU-PTB UPS FAIL ALARM	DI	2	4	4											
SPARE	DI	2	4	5											
SPARE	DI	2	4	6											
SPARE	DI	2	4	7											
HYPOCHL. TRANSFER PMP NO. 1 RUN	DI	2	4	8											
HYPOCHL. TRANSFER PMP NO. 1 ALARM	DI	2	4	9											
HYPOCHL. TRANSFER PMP NO. 1 DISCH. PRESS. HIGH	DI	2	4	10											
HYPOCHL. TRANSFER PMP NO. 1 NOT IN REMOTE	DI	2	4	11											
HYPOCHL. TRANSFER PMP NO. 2 RUN	DI	2	4	12											
HYPOCHL. TRANSFER PMP NO. 2 ALARM	DI	2	4	13											
HYPOCHL. TRANSFER PMP NO. 2 DISCH. PRESS. HIGH	DI	2	4	14											
HYPOCHL. TRANSFER PMP NO. 2 NOT IN REMOTE	DI	2	4	15											
PTB HYPO CHLORINE GAS ALARM 1	DI	2	5	0											
PTB HYPO EYEWASH/SHOWER 1	DI	2	5	1											
PTB CHLORINE GAS ALARM 2	DI	2	5	2											
PTB EYEWASH/SHOWER 2	DI	2	5	3											
LCP-18 SPARE	DI	2	5	4											
SPARE	DI	2	5	5											
SPARE	DI	2	5	6											
SPARE	DI	2	5	7											
SPARE	DI	2	5	8											
SPARE	DI	2	5	9											
SPARE	DI	2	5	10											
SPARE	DI	2	5	11											
SPARE	DI	2	5	12											
SPARE	DI	2	5	13											
SPARE	DI	2	5	14											
SPARE	DI	2	5	15											
BAR-SCREEN NO. 1 START	DO	2	9	0											
SCREW CONVEYOR NO. 1 START/STOP COMMAND	DO	2	9	1											
SCREENING COMPACTOR NO. 1 START/STOP COMMAND	DO	2	9	2											
SPARE	DO	2	9	3											
GRIT CLASSIFIER NO. 1 START/STOP COMMAND	DO	2	9	4											
SCUM PUMP NO. 1 START/STOP COMMAND	DO	2	9	5											
SPARE	DO	2	9	6											
HYPOCHL. FD PMP NO. 1 START	DO	2	9	7											
CROSS COLLECTOR NO. 1 START/STOP COMMAND	DO	2	9	8											
LONG COLLECTOR NO. 1 START/STOP COMMAND	DO	2	9	9											
SPARE	DO	2	9	10											
SPARE	DO	2	9	11											
SPARE	DO	2	9	12											
PRIMARY SLUDGE PUMP NO. 1 START/STOP COMMAND	DO	2	9	13											
PRIMARY SLUDGE PUMP NO. 2 START/STOP COMMAND	DO	2	9	14											
SPARE	DO	2	9	15											
BAR-SCREEN NO. 2 START	DO	2	10	0											
SCREW CONVEYOR NO. 2 START/STOP COMMAND	DO	2	10	1											
SCREENING COMPACTOR NO. 2 START/STOP COMMAND	DO	2	10	2											
SPARE	DO	2	10	3											
GRIT CLASSIFIER NO. 2 START/STOP COMMAND	DO	2	10	4											
SCUM PUMP NO. 2 START/STOP COMMAND	DO	2	10	5											
HYPOCHL. FD PMP NO. 2 START	DO	2	10	6											
CROSS COLLECTOR NO. 2 START/STOP COMMAND	DO	2	10	7											
LONG COLLECTOR NO. 2 START/STOP COMMAND	DO	2	10	8											
SPARE	DO	2	10	9											
SPARE	DO	2	10	10											
SPARE	DO	2	10	11											
PRIMARY SLUDGE PUMP NO. 3 START/STOP COMMAND	DO	2	10	12											
PRIMARY SLUDGE PUMP NO. 4 START/STOP COMMAND	DO	2	10	13											
HYPOCHL. TRANSFER PMP NO. 1 START	DO	2	10	14											
HYPOCHL. TRANSFER PMP NO. 2 START	DO	2	10	15											
BAR-SCREEN NO. 3 START	DO	2	11	0											

Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
SCREW CONVEYOR NO. 3 START/STOP COMMAND	DO	2	11	1											
SPARE	DO	2	11	2											
SCUM CONCENTRATOR START/STOP COMMAND	DO	2	11	3											
SCREW CONVEYOR NO. 4 START/STOP COMMAND	DO	2	11	4											
CROSS COLLECTOR NO. 3 START/STOP COMMAND	DO	2	11	5											
LONG COLLECTOR NO. 3 START/STOP COMMAND	DO	2	11	6											
SPARE	DO	2	11	7											
SPARE	DO	2	11	8											
SPARE	DO	2	11	9											
CROSS COLLECTOR NO. 4 START/STOP COMMAND	DO	2	11	10											
LONG COLLECTOR NO. 4 START/STOP COMMAND	DO	2	11	11											
SPARE	DO	2	11	12											
SPARE	DO	2	11	13											
SPARE	DO	2	11	14											
CRITICAL ALARM - PGTB LUBE OIL RADIO ALARM	DO	2	11	15											
PRIMARY SLUDGE PUMP NO. 5 START/STOP COMMAND	DO	2	12	0											
PRIMARY SLUDGE PUMP NO. 6 START/STOP COMMAND	DO	2	12	1											
CROSS COLLECTOR NO. 5 START/STOP COMMAND	DO	2	12	2											
LONG COLLECTOR NO. 5 START/STOP COMMAND	DO	2	12	3											
CRITICAL ALARM - GULF RUN PUMP STATION	DO	2	12	4											
CRITICAL ALARM - DONALDSON RUN PUMP STATION	DO	2	12	5											
CRITICAL ALARM - RIVERCREST LIFT STATION	DO	2	12	6											
CROSS COLLECTOR NO. 6 START/STOP COMMAND	DO	2	12	7											
LONG COLLECTOR NO. 6 START/STOP COMMAND	DO	2	12	8											
CRITICAL ALARM - POTOMAC YARDS PUMP STATION	DO	2	12	9											
CRITICAL PLANT FLOW ALARM	DO	2	12	10											
CRITICAL PLANT AERATION SYSTEM ALARM	DO	2	12	11											
CRITICAL PLANT CHEMICAL SYSTEM ALARM	DO	2	12	12											
FLOODED SUMP PUMP ALARM	DO	2	12	13											
PCS ZETRON RADIO ALARM OUT NO 5	DO	2	12	14											
PCS ZETRON RADIO ALARM OUT NO 6	DO	2	12	15											
PRIMARY SLUDGE PUMP NO. 7 START/STOP COMMAND	DO	2	13	0											
PRIMARY SLUDGE PUMP NO. 8 START/STOP COMMAND	DO	2	13	1											
CROSS COLLECTOR NO. 7 START/STOP COMMAND	DO	2	13	2											
LONG COLLECTOR NO. 7 START/STOP COMMAND	DO	2	13	3											
CRITICAL ALARM - DOVER RUN PUMP STATION	DO	2	13	4											
CRITICAL ALARM - KIRKWOOD RUN PUMP STATION	DO	2	13	5											
CRITICAL ALARM - MARCEY CREEK PUMP STATION	DO	2	13	6											
CROSS COLLECTOR NO. 8 START/STOP COMMAND	DO	2	13	7											
LONG COLLECTOR NO. 8 START/STOP COMMAND	DO	2	13	8											
CRITICAL ALARM - PALISADES PUMP STATION	DO	2	13	9											
CRITICAL ALARM - ROACHES RUN PUMP STATION	DO	2	13	10											
CRITICAL ALARM - WINDY RUN PUMP STATION	DO	2	13	11											
DCU-PTB NETWORK FAILURE	DO	2	13	12											
DCU-PTB CRITICAL ALARM	DO	2	13	13											
CRITICAL ALARM - RIVERWOOD EJECTOR STATION	DO	2	13	14											
CRITICAL ALARM - RIVER ESTATES EJECTOR STATION	DO	2	13	15											
BAR SCREEN NO. 1 INFLUENT GATE POS.	AI	3	3	0											
PRIMARY SLUDGE PUMP NO. 1 SPD. INDICATION < 0-10V>	AI	3	3	1											
GRIT CHAMBER NO.1 DISCHARGE PRESSURE	AI	3	3	2											
SPARE	AI	3	3	3											
SPARE	AI	3	3	4											
SPARE	AI	3	3	5											
BAR SCREEN NO. 2 INFLUENT GATE POS.	AI	3	4	0											
PRIMARY SLUDGE PUMP NO. 2 SPD. INDICATION < 0-10V>	AI	3	4	1											
GRIT CHAMBER NO.2 DISCHARGE PRESSURE	AI	3	4	2											
SPARE	AI	3	4	3											
SPARE	AI	3	4	4											
SPARE	AI	3	4	5											
BAR SCREEN NO. 3 INFLUENT GATE POS.	AI	3	5	0											
PRIMARY SLUDGE PUMP NO. 3 SPD. INDICATION < 0-10V>	AI	3	5	1											
GRIT CHAMBER NO.3 DISCHARGE PRESSURE	AI	3	5	2											
SPARE	AI	3	5	3											
SPARE	AI	3	5	4											
SPARE	AI	3	5	5											
PRIMARY SLUDGE PUMP NO. 4 SPD. INDICATION < 0-10V>	AI	3	6	0											

Description	Point Type	Rack	Slot	Point	Analog Type (2/4Wire)	Address	Eng. Units Low	Eng. Units High	Eng. Units	Range	Low Low Alarm	Low Alarm	High Alarm	High High Alarm	Comment
SPARE	AI	3	6	1											
GRIT CHAMBER NO.4 DISCHARGE PRESSURE	AI	3	6	2											
SPARE	AI	3	6	3											
SPARE	AI	3	6	4											
SPARE	AI	3	6	5											
PRIMARY SLUDGE PUMP NO. 5 SPD. INDICATION < 0-10V>	AI	3	7	0											
PTB-SCUM-SYS-TEMP - SCUM-BIN-PROCESS-TEMP	AI	3	7	1											
PTB-SCUM-SYS-TEMP - SCUM-PUMP-CASING-TEMP	AI	3	7	2											
PTB-SCUM-SYS-TEMP - SCUM-BIN-WALL-TEMP	AI	3	7	3											
PTB-SCUM-SYS-TEMP - SCUM-BIN-WALL-TEMP	AI	3	7	4											
PTB-SCUM-SYS-TEMP - SCUM-BIN-HEATING-ELEMENT	AI	3	7	5											
PRIMARY SLUDGE PUMP NO. 6 SPD. INDICATION < 0-10V>	AI	3	8	0											
SPARE	AI	3	8	1											
SPARE	AI	3	8	2											
SPARE	AI	3	8	3											
SPARE	AI	3	8	4											
SPARE	AI	3	8	5											
PRIMARY SLUDGE PUMP NO. 7 SPD. INDICATION < 0-10V>	AI	3	9	0											
SPARE	AI	3	9	1											
SPARE	AI	3	9	2											
SPARE	AI	3	9	3											
SPARE	AI	3	9	4											
SPARE	AI	3	9	5											
PRIMARY SLUDGE PUMP NO. 8 SPD. INDICATION < 0-10V>	AI	3	10	0											
SPARE	AI	3	10	1											
SPARE	AI	3	10	2											
SPARE	AI	3	10	3											
SPARE	AI	3	10	4											
SPARE	AI	3	10	5											
POTOMAC INTERC. CHAMB. FLOW - FLOW	AI	3	11	0											
HYPOCHL. FD PMP NO. 1 & 2 FLOW	AI	3	11	1											
SCUM CONCENTRATOR-CHAMBER LEVEL	AI	3	11	2											
SPARE	AI	3	11	3											
SPARE	AI	3	11	4											
FOUR MILE RUN INTERCEPTOR - FLOW	AI	3	11	5											
POTOMAC INTERC. CHAMB. FLOW - FLOW	AI	3	12	0											
HYPOCHL. TRANSFER PMP NO. 1 & 2 FLOW	AI	3	12	1											
SPARE	AI	3	12	2											
SPARE	AI	3	12	3											
SPARE	AI	3	12	4											
SPARE	AI	3	12	5											
BAR-SCREEN NO. 1-INFLUENT-GATE-O/C-CMD	AO	3	13	0											
HYPOCHL. FD PMP NO. 1 SPEED CONTROL	AO	3	13	1											
PRIMARY SLUDGE PUMP NO. 1 SPD. CONTROL	AO	3	13	2											
PRIMARY SLUDGE PUMP NO. 2 SPD. CONTROL	AO	3	13	3											
PRIMARY SLUDGE PUMP NO. 3 SPD. CONTROL	AO	3	13	4											
SPARE	AO	3	13	5											
BAR-SCREEN NO. 2-INFLUENT-GATE-O/C-CMD	AO	3	14	0											
HYPOCHL. FD PMP NO. 2 SPEED CONTROL	AO	3	14	1											
PRIMARY SLUDGE PUMP NO. 4 SPD. CONTROL	AO	3	14	2											
PRIMARY SLUDGE PUMP NO. 5 SPD. CONTROL	AO	3	14	3											
PRIMARY SLUDGE PUMP NO. 6 SPD. CONTROL	AO	3	14	4											
SPARE	AO	3	14	5											
BAR-SCREEN NO. 3-INFLUENT-GATE-O/C-CMD	AO	3	15	0											
PRIMARY SLUDGE PUMP NO. 7 SPD. CONTROL	AO	3	15	1											
PRIMARY SLUDGE PUMP NO. 8 SPD. CONTROL	AO	3	15	2											
HYPOCHL. TRANSFER PUMP NO. 1 SPEED CONTROL	AO	3	15	3											
HYPOCHL. TRANSFER PUMP NO. 2 SPEED CONTROL	AO	3	15	4											
SPARE	AO	3	15	5											

Description	Point Type	Rack	Slot	Point
PTB-VALV-PEW-PCL-INF - OPENED	DI	1	3	0
PTB-VALV-PEW-PCL-INF - CLOSED	DI	1	3	1
PTB-VALV-PEW-PCL-INF - NOT IN REMOTE	DI	1	3	2
PTB-VALV-FERRIC-PCL-INF - OPENED	DI	1	3	3
PTB-VALV-FERRIC-PCL-INF - CLOSED	DI	1	3	4
PTB-VALV-FERRIC-PCL-INF - NOT IN REMOTE	DI	1	3	5
EXISTING ABB DCU-1 - NORTH FERRIC SYS COMMON ALARM	DI	1	3	6
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	DI	1	3	7
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	DI	1	3	8
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	DI	1	3	9
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	DI	1	3	10
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	DI	1	3	11
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	DI	1	3	12
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	DI	1	3	13
RIO-PTB1 POWER MONITOR (ON)	DI	1	3	14
RIO-PTB1 PANEL HIGH TEMPERATURE ALARM	DI	1	3	15
RIO-PTB1 UPS ON BATTERY POWER ALARM	DI	1	4	0
RIO-PTB1 UPS LOW BATTERY ALARM	DI	1	4	1
RIO-PTB1 UPS FAIL ALARM	DI	1	4	2
SPARE	DI	1	4	3
SPARE	DI	1	4	4
SPARE	DI	1	4	5
SPARE	DI	1	4	6
SPARE	DI	1	4	7
SPARE	DI	1	4	8
SPARE	DI	1	4	9
SPARE	DI	1	4	10
SPARE	DI	1	4	11
SPARE	DI	1	4	12
SPARE	DI	1	4	13
SPARE	DI	1	4	14

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Description	Point Type	Rack	Slot	Point
SPARE	DI	1	4	15
RIO-PTB1 CRITICAL ALARM	DO	1	9	0
SPARE	DO	1	9	1
SPARE	DO	1	9	2
SPARE	DO	1	9	3
SPARE	DO	1	9	4
SPARE	DO	1	9	5
SPARE	DO	1	9	6
SPARE	DO	1	9	7
SPARE	DO	1	9	8
SPARE	DO	1	9	9
SPARE	DO	1	9	10
SPARE	DO	1	9	11
SPARE	DO	1	9	12
SPARE	DO	1	9	13
SPARE	DO	1	9	14
SPARE	DO	1	9	15
EXISTING ABB DCU-1 - TEMP_PLANT_FLOW	AI	1	11	0
EXISTING ABB DCU-1 - TEMP_CL2_CCT1	AI	1	11	1
EXISTING ABB DCU-1 - TEMP_CL2_CCT2	AI	1	11	2
EXISTING ABB DCU-1 - TEMP_CL2_OUTFALL	AI	1	11	3
**TEMP CONNECTION - ASE1 PHOSPHATE	AI	1	11	4
BACKWASH WASTE TANK BAY NO.1 LEVEL	AI	1	11	5
PTB-VALV-PEW-PCL-INF - POSITION	AI	1	12	0
PTB-VALV-FERRIC-PCL-INF - POSITION	AI	1	12	1
EXISTING ABB DCU-1 - TOTAL PLANT INFLUENT	AI	1	12	2
EXISTING ABB DCU-1 - PRIMARY EFFLUENT	AI	1	12	3
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	AI	1	12	4
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	AI	1	12	5
PTB-VALV-PEW-PCL-INF - POSITION COMMAND	AO	1	14	0
PTB-VALV-FERRIC-PCL-INF - POSITION COMMAND	AO	1	14	1

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Description	Point Type	Rack	Slot	Point
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	AO	1	14	2
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	AO	1	14	3
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	AO	1	14	4
EXISTING ABB DCU-1 - I/O POINTS TO BE DETERMINED	AO	1	14	5
SPARE	AO	1	15	0
SPARE	AO	1	15	1
SPARE	AO	1	15	2
SPARE	AO	1	15	3
SPARE	AO	1	15	4
SPARE	AO	1	15	5



## SECTION 406121.10 - PROCESS CONTROL SYSTEM 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. Section includes process control system testing.
- B. Related Requirements:
  - 1. Refer to Section 406100 “Process Control and Enterprise Management Systems and General Provisions.”
- C. Furnish all labor, materials, equipment and incidentals required to complete the testing of all devices and systems furnished and installed as detailed on Drawings, and as specified herein.
- D. The Applications Engineering System Supplier (AESS), has been pre-selected to perform Applications Engineering. Provide support services to AESS as defined herein.
- E. AESS to program existing DCU as shown on Drawings. PLC’s, HMI’s, OIT’s, and similar equipment provided by equipment vendors to be programmed by respective equipment vendor.
  - 1. AESS scope of work includes DCU and Programmable Logic Controller (PLC) programming, testing of PLC logic, Human Machine Interface (HMI) graphics development, database development, report development, and startup/training activities associated with the configured portions of the PLC/HMI/OIT system.
- F. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions” for other general requirements.

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”
- B. Conduct a field-testing coordination meeting two weeks prior to start of field acceptance testing. Purpose of this meeting is to discuss specifics of PCSS's proposed tests and to provide a forum for coordinating required AESS field-testing. Meeting will last up to one business day.

#### 1.4 ACTION SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”
- B. Testing Submittals - Submit, in one submittal, the following testing related documents:
  - 1. Status signoff forms:
    - a. Develop and submit project specific I/O Status signoff forms to be used during factory and field testing to organize and track each loop's inspection, adjustment, calibration, configuration, and testing status and sign off. Include sign-off forms for each testing phase showing all loops.
      - 1) Example forms are shown in the Appendices.
      - 2) Separate forms for factory and field testing can be used, or they can be combined, at the discretion of the PCSS.
      - 3) Submit testing forms prior to start of testing.
  - 2. Testing Procedures:
    - a. Submit detailed procedures proposed to be followed for the PCSS portion of each of the tests specified herein. The test procedures serve as the basis for the execution of the required tests to demonstrate that the system meets and functions as specified. At a minimum, provide the following test procedures:
      - 1) Network and Communications Testing.
      - 2) I/O Testing.
      - 3) UPS.
      - 4) Control panel power, indicators, and hardwired logic tests.
    - b. Structure documents in an orderly and easy to follow manner to facilitate an efficient and comprehensive test.
    - c. Test procedures indicate all pre-testing setup requirements, all required test equipment, and simulation techniques to be used.
    - d. Do not start testing until all Testing Submittals have been approved.
    - e. AESS will write the software related test procedures.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For Test Documentation of system:
  - 1. Upon completion of each required test, document the test by submitting a copy of the signed off Testing Status forms. Testing shall not be considered complete until the signed-off forms have been submitted and approved. Submittal of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 TESTING - GENERAL

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”
- B. Results of testing shall be tracked on a project specific status sign off form or similar document. The PCSS shall be responsible for maintaining the sheet. Appendix of this Section has an example template for this sheet.
- C. Tests the PCSS is required to perform are as follows:
  - 1. Field Testing:
    - a. Operational Readiness Test (ORT).
    - b. Site Acceptance Test (SAT).
- D. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide all special testing materials and equipment required for a suitable means of simulation.
- E. PCSS shall coordinate all required testing with Contractor, affected Subcontractors, Engineer, and Owner. Commissioning will be performed across 5-10 sessions to accommodate requirements of section 018000 “Maintenance of Plant Operations (MOPO)”.
- F. No equipment shall be shipped to jobsite until Engineer or Owner has received all Factory Testing results and approved the system as ready for shipment.
- G. Engineer reserves the right to test or re-test any functions.
- H. Correction of Deficiencies:
  - 1. Deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to Owner.
  - 2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until specified requirements are met. This work shall be performed at no additional cost to Owner.

### 3.2 FIELD TESTING - OPERATIONAL READINESS TEST (ORT)

- A. Purpose of ORT is to check that process equipment, instrument installation, instrument calibration, instrument configuration, field wiring, control panels, and all other related system components are ready to monitor and control the processes. This test will determine if the equipment is ready for operation.

- B. This test shall take place prior to startup. Prior to starting this test, relevant process equipment shall be installed and mechanically tested, instruments installed, control panels installed, and field wiring complete.
- C. Required Documents for Test:
  - 1. Master copy of the PCSS developed field testing signoff forms.
  - 2. Testing procedures.
  - 3. Calibration forms.
- D. These inspections, calibrations, and tests do not require witnessing. However, Engineer may review and spot-check the testing process periodically. All deficiencies found shall be corrected by the PCSS prior to start-up.
- E. PCSS shall maintain Sign-off forms and Calibration forms at job site and make them available to Engineer/Owner at any time.
- F. Following steps shall be performed as part of the ORT:
  - 1. Instrument calibration, configuration, and set-up.
  - 2. PCSS hardware and I/O testing
  - 3. I/O Testing to the HMI and OITs with AESS.
  - 4. Testing of Automatic control strategies with AESS.
- G. Instrument calibration, configuration, and set-up:
  - 1. Calibrate, configure, and set-up all components and instruments to perform the specified functions.
  - 2. Calibration form:
    - a. For any component or instrument requiring dip switch settings, calibration, or custom configuration, maintain a calibration form in field documenting this information. These forms shall provide a summary of the actual settings used in field to allow an Instrument technician to replace device entirely and configure it to function as it did before.
    - b. This information shall be added to Instrument data sheet, shall be added to a copy of manufacturer's standard "Configuration Sheet", or a separate form shall be created.
      - 1) If a separate form, the form shall list the Project Name, Loop Number, ISA Tag Number, I/O Module Address, Manufacturer, Model Number/Serial Number, Output Range and Calibrated Value.
    - c. Some examples of required information are:
      - 1) For Discrete Devices: Actual trip points and reset points.
      - 2) For Instruments: Any configuration or calibration settings entered into instrument
      - 3) For Controllers: Mode settings (PID).
      - 4) For I/O Modules: Dip switch settings, module configuration (if not documented in the native programming documentation).

- d. Maintain a copy of these forms in field during testing and make them available for inspection at any time.
- e. For any device that allows a software back-up of configuration files to a laptop, make configuration files available to Engineer/Owner for inspection. Submit as part of O&M Manual as specified in Section 40 61 00.

H. PCSS hardware and I/O testing:

1. Purpose of PCSS hardware and I/O signal testing is to check that process equipment, instrument installation, calibration, configuration, field wiring, and control panels are set-up correctly to monitor and control the processes. This test is commonly referred to as a "loop test" or an I/O checkout.
2. This test shall follow installation of the process control system components. This test shall be performed independent of the AESS as this test will determine if the system is ready for the AESS testing as defined below.
3. PCSS in conjunction with the Contractor and AESS shall test signals under process conditions. Preferred test method will always be to execute the test wherever possible to the end elements. For example, the preferred test will prove valve open/close limit switches by operating the valve, not by installing a jumper on the limit switch contacts. However, if equipment or process is not available to test signal over its entire calibrated range, PCSS may test using a simulation method and make a note on sign-off form.
4. An I/O Signal test shall be performed by PCSS as part of ORT prior to AESS arriving on site to test the software:
  - a. Discrete Input: At device or instrument, change signal condition from inactive to active state. Observe results on all indicators within the loop such as PLC I/O register, pilot light, horn, beacon etc. as shown on P&IDs.
  - b. Discrete Output: Signals shall be tested by forcing the output on in the output register, then verify equipment responds accordingly.
  - c. Analog Input: Test analog signal over entire engineering range at various intervals including 0 percent, 50 percent, and 100 percent as well as on increasing and decreasing range. Observe results on all indicators within the loop such as PLC I/O register, recorders, digital indicators, etc.
  - d. Analog Output: Signals shall be tested by entering values in the output register to force the output to zero percent, 50 percent, and 100 percent of full scale, then verifying equipment responds accordingly.
5. PCSS shall maintain Field Testing Spreadsheet at job site and make them available to Engineer/Owner at any time.
6. This test includes interface with existing PLC equipment that controls other processes. Perform testing in such a manner that the main operation of the PLC and the processes are unaffected. AESS may assist by generating output signals required for I/O checkout. Provide written notice no less than 1 week in advance that the system is ready for I/O checkout that will require AESS assistance.
7. These inspections, calibrations, and tests do not require witnessing. However, Engineer will review and spot-check the PCSS test process periodically. All deficiencies found shall be corrected by PCSS prior to start-up.
8. Prior to AESS checkout of I/O to HMI, PCSS is required to submit a Field Testing Sign off spreadsheet with ORT sections completed to engineer for review along with any instrument calibration and configuration reports for PCSS supplied instruments in order

to document the calibration and configuration procedures of instruments and checkout of I/O.

- I. Input/Output (I/O) Testing to the HMI and OITs with AESS.
  1. Purpose of the I/O testing to HMI and OITs with AESS is to check that the Instruments and field equipment are connected properly and work from the end device, through PLC, to HMI and OIT units.
  2. PCSS in conjunction with the Contractor and AESS shall test signals under process conditions.
  3. Following I/O tests shall be performed:
    - a. Discrete Input: At the device or instrument, change signal condition from the inactive to active state. Observe results on all indicators within loop such as HMI screens, OIT screens, pilot lights, horns, beacons, etc.
    - b. Analog Input: Test analog signal over entire engineering range at various intervals including 0 percent, 50 percent, and 100 percent as well as on increasing and decreasing range. Observe results on all indicators within loop such as HMI screens, OIT screens, recorders, digital indicators, etc.
    - c. Discrete Output: Signals shall be tested by switching the equipment to manual control at HMI and OIT nodes and turning the output on or using other means to turn the output on. Then verify equipment responds accordingly.
    - d. Analog Output: Signals shall be tested by switching the equipment to manual control at HMI and OIT nodes and ramping the output up and down. Then verify equipment responds accordingly.
- J. Testing of Automatic Control Strategies:
  1. All automatic control strategies shall be verified using actual process equipment and instruments, or other means, to verify logic performs as expected. Verify faults and logical failure scenarios for control strategies such as instrument failures, equipment failures, loss of communication between HMI Server and PLC, loss of peer-to-peer communication, out of range testing for analog inputs, loss of power, and all other strategies specified in control strategy document. This test shall be run by AESS. PCSS shall support AESS by simulating signals, jumping out switches, and any other related testing support as needed.
- K. For all panels with enclosures modified by this contract, internal control panel temperature shall be tested under full running conditions to ensure proper cooling/ventilation is being provided.
- L. After coordinating with Operations, power failures for each system, Screening and Scum Concentration, shall be simulated to confirm equipment recovers as specified in Contract Documents.
- M. Upon successful completion of ORT, PCSS shall submit a record copy of test results and request scheduling of system startup.

### 3.3 FIELD TESTING - FUNCTIONAL DEMONSTRATION TEST (FDT)

- A. A separate FDT is not required.



### 3.4 FIELD TESTING - SITE ACCEPTANCE TEST (SAT)

- A. While this test is proceeding, Engineer and Owner shall have full use of system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain responsibility of Owner and decision of plant operators regarding plant operations shall be final.
- B. During this test, PCSS personnel shall be present to address any potential issues that would impact system operation. PCSS is expected to provide personnel for this test who have an intimate knowledge of equipment supplied as part of this system. When PCSS personnel are not on-site, PCSS shall provide cell phone/pager numbers that Owner personnel can use to ensure that support staff are available by phone and/or on-site within four hours of a request by operations staff.
- C. Any malfunction during test shall be analyzed and corrections made by PCSS. In event of rejection of any part or function, PCSS shall perform repairs or replacement within 5 days.
- D. Throughout duration of SAT, no software or hardware modifications shall be made to system without prior approval from Owner or Engineer.

END OF SECTION 406121.10

**APPENDIX 40 61 21-A: EXAMPLE INPUT/OUTPUT (I/O) STATUS SIGN OFF FORM**

An example template for I/O Status signoff form to be used for documenting testing results to Owner is attached. PCSS is required, prior to testing, to create a project specific I/O Status signoff form based on attached template or approved equal. PCSS may obtain an electronic copy of template from Engineer or develop it on their own.

[Project Name] Appendix A - Input/Output (I/O) Status Sign-Off Form

4-Jun-14

PLC	Signal Tag	Description	Range or Active State when closed	P&ID	Signal	Reck Slot	Chan nel	Instru- ment Alarm Setpoint complete	Date	I/O Tested	Date	Notes
PLC-SC	LIT-4000-1	Secondary Clarifier No. 1 Sludge Level	0-10 ft	8	AI	2	1					
PLC-SC	LIT-4010-3	Secondary Clarifier No. 3 Sludge Level	0-10 ft	8	AI	2	1					
PLC-SC	SI-4100-1	RAS Pump No. 1 Speed Feedback	0-100%	14	AI	2	1					
PLC-SC	SI-4100-4	RAS Pump No. 4 Speed Feedback	0-100%	15	AI	2	1					
PLC-SC	FIT-4102-1	RAS Flow Pumps 1-3	0-1900 GPM	14	AI	2	1					
PLC-SC	SI-4110-1	WAS Pump No. 1 Speed Feedback	0-100%	14	AI	2	1					
PLC-SC	N/A	Spare Slot	N/A	Spare	2	5	N/A					
PLC-SC	SC-4100-1	RAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	SC-4100-2	RAS Pump No. 2 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	SC-4100-3	RAS Pump No. 3 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	SC-4110-1	WAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7					
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7					
PLC-SC	TSH-4000-1	Secondary Clarifier No. 1 High Temp	Normal	8	DI	3	1					
PLC-SC	XA-4000-1	Secondary Clarifier No. 1 Motor Overload	Normal	8	DI	3	1					
PLC-SC	WAH-4000-1	Secondary Clarifier No. 1 High Torque	Normal	8	DI	3	1					
PLC-SC	WAH-4000-1	Secondary Clarifier No. 1 High High Torque	Normal	8	DI	3	1					
PLC-SC	YRI-4000-1	Secondary Clarifier No. 1 On/Off	On	8	DI	3	1					
PLC-SC	YRI-4000-1	Secondary Clarifier No. 1 In Remote	In Remote	8	DI	3	1					
PLC-SC	YFI-4100-1	RAS Pump No. 1 VFD Fault	Normal	14	DI	3	1					
PLC-SC	FAL-4100-1	RAS Pump No. 1 Low Flow	Normal	14	DI	3	1					
PLC-SC	Spare	Spare	Normal	14	DI	3	1					
PLC-SC	YRI-4100-1	RAS Pump No. 1 Running	Running	14	DI	3	1					
PLC-SC	YFI-4110-1	WAS Pump No. 1 VFD Fault	Normal	14	DI	3	1					
PLC-SC	YRI-4110-1	WAS Pump No. 1 Running	Running	14	DI	3	1					
PLC-SC	YCI-4110-1	WAS Pump No. 1 In Remote	In Remote	14	DI	3	1					
PLC-SC	HSS-4000-2	Secondary Clarifier No. 2 Start Command	Start	8	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-4100-2	RAS Pump No. 2 Start Command	Start	14	DO	4	6					
PLC-SC	HSS-7000-2	Sludge Holding Tank Blower No. 2 Start Command	Start	17	DO	4	6					
PLC-SC	HSS-4100-5	RAS Pump No. 5 Start Command	Start	15	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-4105-1	Secondary Sludge Pump No. 2 Start/Stop	Start	15	DO	4	6					
PLC-SC	HSS-4110-2	WAS Pump No. 2 Start/Stop Command	Start	15	DO	4	6					
PLC-SC	7100-FOI-1	Sludge Holdout LCP Pumping Indicator	Pumping	17	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-7115-2	Sludge Holding Tank Mixer No. 2 Start	Start	17	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-7117-2	Sludge Holding Tank Discharge Valve No. 2 Open CMD	Open	17	DO	4	6					
PLC-SC	HSS-7117-2	Sludge Holding Tank Discharge Valve No. 2 Close CMD	Close	17	DO	4	6					
PLC-SC	HSS-7120-2	TS Transfer Pump No. 2 Start Command	Start	17	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					



## SECTION 406126 - PROCESS CONTROL SYSTEM TRAINING

### 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.
- B. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
- C. Provide videotaping and repetitive sessions as specified in Division 01.

#### 1.2 SUMMARY

- A. Section includes process control system training.
- B. Furnish training as specified herein.
- C. This Section covers the training requirements for all devices and systems furnished and installed as detailed on the Drawings.

#### 1.3 ACTION SUBMITTALS

- A. Preliminary Training Plan Submittal:
  - 1. Prior to the preparation of the Final Training Plans, submit outlines of each training course including course objectives and target audience, resumes of instructors, prerequisite requirements for each class, and samples of handouts for review.
- B. Final Training Plan Submittal:
  - 1. Upon receipt of the Engineer's comments on the preliminary training plan, submit the specific proposed training plan with the following:
    - a. Definitions, objectives, and target audience of each course.
    - b. Schedule of training courses including proposed dates, duration and locations of each class.
    - c. Complete copy of all proposed handouts and training materials bound and logically arranged with all materials reduced to a maximum size of 11 inches by 17 inches, then folded to 8.5 inches by 11 inches for inclusion into the binder.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. The training and instruction shall be directly related to the system being supplied. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.
- B. Coordinate all training schedules with and at the convenience of the Owner, including shift training required to correspond to the Owner's working schedule.
- C. All onsite instructors must be intimately familiar with the operation and control of the Owner's facilities.
- D. Provide detailed training manuals to supplement the training courses including specific details of equipment supplied and operations specific to the project. The manuals shall be provided in hardcopy for each student. Provide electronic copy of each training manual in PDF format for Owner's future use.
- E. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to Owner.
- F. The Owner reserves the right to videotape all custom training sessions. All training tapes become the sole property of the Owner.

### 3.2 TRAINING SUMMARY

- A. Provide the following training courses listed in the summary table below:

Description	Minimum Course Duration (hours)	Maximum Number of Trainees per Course	Number of Times Course to be Given	Intended Audience
Instrument manufacturer training - analyzers	8	3	1	Maintenance, Operations
Instruments	5	2	1	Maintenance
Instruments - Operator familiarity	2	8	4	Operations

- B. Definitions of audience roles:
  - 1. Maintenance - personnel responsible for maintaining the field controller hardware and instrumentation system.
  - 2. Operations - personnel responsible for daily plant operations.

### 3.3 ONSITE TRAINING

#### A. Instrument Manufacturer Training:

1. Provide manufacturer instrument training for those instruments where specifically indicated in the Instruments section. This is on-site training provided by an authorized representative of the manufacturer. The manufacturer's representative is required to be fully knowledgeable in the operation and maintenance of the equipment.

#### B. Instrument Training:

1. Provide instruction on the maintenance of the field and panel instrumentation for the Owner's instrumentation technicians. Conduct this training at the Owner's facility prior to equipment startup. Training program is required to include the following elements:
  - a. Training in standard hardware maintenance for the instruments provided.
  - b. Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up for this Contract.
  - c. Testing, adjustment, and calibration procedures.
  - d. Troubleshooting and diagnosis.
  - e. Maintenance and frequency.

#### C. Instruments - Operator familiarity:

1. Provide operator level instruction on the use of the field and panel instrumentation for the Owner's operations staff. This training shall take place at the Owner's facility. Include hands on demonstration of the information each transmitter indicates, and the method used to retrieve any operator information from the transmitter, including use of pushbuttons and interpretation of international graphic symbols used on the instruments.

END OF SECTION 406126





## SECTION 406196 - PROCESS CONTROL DESCRIPTIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes process control descriptions for the screening and scum concentrator systems.
- B. This Section is provided to clarify the control strategies to be used to program the system.

### PART 2 - PRODUCTS

- 2.1 Not Used.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. The control descriptions are broken into areas. The following is a list of areas and the loop numbers associated with each area.

1. Screening (I-2)	2010000-2024100
2. Scum Concentration (I-3)	2100000-2104300
3. HVAC (I-4)	1001000-1001999
4. Gas Detection (I-4)	1002000-1002999
- B. The control descriptions are sorted by loop number for each area. The loop index has three columns associated with it; Loop Number, Loop Description, and Page. Each loop is associated with a specific SCADA I/O cabinet location to which it shall communicate.
- C. The control descriptions are broken into a hierarchical layer concept. There may be one layer or multiple layers per loop, depending upon that loop. An example of multiple layered loop is as follows. The lowest layer of control, local control, is at that piece of equipment or that piece of equipment's panel or drive. The second layer of control is at an intermediate control panel between the equipment and the SCADA I/O or vendor's PLC I/O. The third layer would be at the vendor's PLC or microprocessor touchscreen station. The highest layer of control is by the SCADA PLC System with its associated operator workstations (OWS) in the main control room, remote office locations, and satellite locations operator interface terminals (OITs). The PCS refers to both the SCADA PLC, which does the actual monitoring and control logic for the

process equipment and the SCADA operator workstation (OWS), which are computers that have graphical software that interface to the PLC software for monitoring and implementing all operator-required tasks to control that process equipment. Any functions done in the operator workstations also take place at all the SCADA OITs.

### 3.2 CONTROL FUNCTION DEFINITIONS AND GENERAL CRITERIA

- A. The hardware and/or software functions noted by this paragraph reference are to be implemented by the PCS control system specified herein.
- B. The following list of ISA abbreviations is typical of those utilized. The description, following the abbreviation, summarizes the basic function to be implemented in the PCS software.
  - 1. HS: Represent selector switches or pushbuttons. Function shall be similar to their hardware counterparts. Examples are as follows:
    - a. HSO-Open Command.
    - b. HSC-Close Command.
    - c. HSS-Start/Stop Command.
    - d. HSA Selector switch in computer, auto or remote position.
    - e. HSH Selector switch in maintenance position.
  - 2. MI: Represents equipment status (i.e., availability, running, in remote, etc.) implemented by a change of color on the OWS symbol for this equipment. For motor driven equipment such as pumps, blowers, compressors, etc., availability contact represents remote operation and no alarm conditions. Examples are as follows:
    - a. MRI-Motor running status.
    - b. MA-Motor failure or overload status.
  - 3. XAHH, XAH, XAL, XALL, UA, etc.: Represent high, low, or general alarms implemented on the OWS.
  - 4. FIC, PIC, AIC, etc.: Represent PID process controllers implemented in a computer logic algorithm incorporating proportional, integral, and/or derivative modes. Local/remote and manual/auto capabilities shall be provided.
  - 5. FI, LI, PI, AI, SI, TI, II, JI, ZI etc.: Represent digital output display on the CRT of a process variable in engineering units and/or a dynamic representation of the variable by symbol or graphical means.
  - 6. FIR, PIR, AIR: Represent values stored on the hard disk to provide the data for historical trend graphics of process variables against time (or other selected variables).
  - 7. ZSL, ZSO, ZSC etc.: Represent low, open or close limit positions implemented on the OWS.
- C. All interlocks that are represented, before the local operational descriptions, or are stated as hardwired interlocks, shall interlock all the controls locally and at the PCS or at the vendor PLCs. The SCADA PLC shall be programmed to shut down that equipment if that hardwired interlock is also wired to the SCADA PLC.
- D. All interlocks that are represented in a particular layer of the operational descriptions, shall interlock all the controls in that layer and all layers after it. However, the interlock shall not interlock the commands in the layer before it.

- E. The SCADA system shall stop a motor or drive in its program if it does not receive the auto or remote status or one of its software interlocks trip. If the drive or motor is in hand or remote it will continue to run but the SCADA start/stop output will be open.
- F. All motors that are requested to start by an operator or an automatic program shall alarm if the run confirm status for that motor does not activate within two seconds. If a motor stops by an interlock or stops without any operator or SCADA intervention, then that motor shall go into alarm. All motors that are stopped by a program or the operator shall not go into an alarm.
- G. All valves that are requested to open by an operator or an automatic program shall alarm if the open feedback status for that valve does not activate within ten seconds. All valves that are requested to close by an operator or an automatic program shall alarm if the close feedback status for that valve does not activate within ten seconds.
- H. Motors that have an H/O/A shall indicate to the operator that the pump is being run in the "Hand" position. A motor is being run in "Hand" when the "Auto" position is not true and the run confirm status is true. If not in "Auto" the SCADA PLC shall open up its output contact to stop (shutdown) the pump from SCADA.
- I. All motors associated with the Screening and Scum Concentration equipment shall be programmed so if a motor stops due to an interlock or operator command, it shall not be restarted automatically once the problem with the motor has been resolved. The run confirms of all motors shall seal in the control output to the motor once the momentary start command drops out. The run confirms shall be on a two second timer delay in that if the run confirm is not present after two seconds, the contact output to the motor from the PLC shall drop out. Thus, the only way a motor can be restarted after two seconds by the SCADA system is if the operator reinitiates the start command for that motor on the OWS or when that motor control at the OWS is placed in complete automatic mode and the SCADA computer through logic/interlocks requests the motor to run.
- J. Terminology associated with interlocks is as follows:
  - 1. When a contact or status is true, the SCADA computer will receive power to its input channel. The SCADA computer registers this as a binary bit of one.
  - 2. When a contact or status is false, the SCADA computer will receive no power (open circuit) to its input channel. The SCADA computer registers this as a binary bit of zero.
- K. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card, the following SCADA programming shall take place:
  - 1. Alarm the signal at any local OITs and in the PCS system.
  - 2. If the analog signal is associated with a control loop or ratio control loop that loop shall go into manual.
  - 3. If the analog signal is used in a calculation, that calculation shall use the last good analog signal. The computer shall place the control loop in manual if using the calculation.
- L. Disable all alarms on analog inputs unless specifically called for in the drawings or specifications.
- M. All interlocks that shutdown (Stop a piece of equipment and prevent it from being restarted or moved) shall be shown on the faceplate pop-up graphic for that piece of equipment.

- N. The run confirms or on status of all motors and lamps shall be accumulated to calculate a run time status of the equipment on the PCS graphic. Each run time accumulation shall come with a reset button on the PCS screen.
- O. All flow indications shall be totalized daily. Do not totalize if the analog signal is outside the 4-20 mA range. Do not totalize if the value of the flow input is less than 2% of the full range of the input.
- P. Logic Requirements for Loss of Power and Restoration:
  - 1. Motors at or associated with the Screening and Scum Concentration Equipment shall be programmed to restart on normal power if that motor is still in auto when the motor stops due to a power outage. If a motor stops and the HOA switch is not in auto, the motor shall not be restarted automatically by the SCADA system without operator or SCADA logic intervention. Thus, the only way that motor when placed back in auto can be started by the SCADA system is if the operator reinitiates the start command for that motor on the OWS or when that motor control at the OWS is placed in complete automatic mode and the SCADA computer through logic/interlocks requests the motor to run.

### 3.3 INDIVIDUAL CONTROL DESCRIPTIONS AND CONTROL SEQUENCES

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END OF SECTION 406196

## LOOPS 201-0000, 0001, 0002 INFLUENT CHANNEL LEVEL

**General:** The plant influent channel level is measured and monitored by redundant non-contact radar level sensors and a high-high level float switch. The continuous level feedback shall be used to control the speed of the screens based on operator level setpoints.

**Control:**

Local:

None.

PCS:

The operator shall have the ability through the PCS to place the level transmitters into one of three control modes: Level 1, Level 2, or Auto. Auto uses and displays the higher of the two levels.

The Auto control mode is only available if an Out of Range alarm is not detected for either influent level transmitter and both level transmitters are in service. The current level based on the active control mode shall be transmitted to PCS for remote monitoring.

Placing a level transmitter out of service shall automatically place the level control mode to the other transmitter. Similarly, if an Out of Range alarm is detected for a level transmitter, the PLC shall automatically place the level control mode to the other transmitter, only if the other level transmitter is in service and the out of range alarm is not active.

The PLC shall compare the readings of the level transmitters and generate a Deviation alarm if the level transmitters differ by more than 6 inches. The following conditions shall disable the alarm:

- Control mode is Level 1 or Level 2
- Out of Range alarm is active for one or more level transmitters
- One of the level transmitters is placed out of service

All alarms shall clear automatically when the alarm condition is no longer active.

The influent channel level shall control the speed of the screens.

**Alarms / Monitoring:**

Local:

Level 1 Indication (LIT)  
Level 2 Indication (LIT)

PCS:

Level High Alarm (LAHH)  
Level 1 Indication (LI)  
Level 2 Indication (LI)  
Deviation Alarm (XA)

**LOOP 201-1101 BARSCREEN 1 INFLUENT SLIDE GATE**

**General:** The influent slide gate is manually or automatically controlled to allow water to enter the screen channel from the actuator or PCS.

**Control:**

Local:

The gate can be manually opened or closed from the actuator.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the gate will be controlled at the actuator.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the gate will be turned off.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the gate shall be transferred to PCS.

PCS:

The operator will be able to control the influent gate in manual and automatic modes from the PCS.

**Manual:** The gate can be manually opened or closed from the PCS.

**Auto:** The influent gate shall open 10 seconds after the effluent gate limit switches are tripped.

When a channel is taken offline, the influent gate shall close.

**Alarms / Monitoring:**

Local:

Opened (ZSO)

Closed (ZSC)  
Fault (XA)

PCS:

Opened (ZSO)  
Closed (ZSC)  
Fault (XA)  
H/O/A Switch (HS) is in "Auto"

**LOOP 201-2101 BARSCREEN 2 INFLUENT SLIDE GATE**

**General:** Functionally identical to Loop 201-1101.

**LOOP 201-3101 BARSCREEN 3 INFLUENT SLIDE GATE**

**General:** Functionally identical to Loop 201-1101.

**LOOP 201-1000 BARSCREEN 1**

**General:** The screen removes debris from the water in the channel. The screen can be controlled at the local control panel or from PCS. The barscreen channels operate in a lead/lag1/lag2.

**Control:**

**Hardwired Interlocks:**

A high motor winding temperature switch (TSH) shall be wired to the motor starter. If the switch is tripped, the motor shall stop. The motor can be reset at the VFD in the panel room.

When the E-Stop pushbutton at the local panel or at the screen is pressed, the screen shall stop immediately. When the emergency pull cord is pulled, the screen stops immediately.

Local:

The screen can be run at a constant speed and stopped from the local control panel. The speed can be selected using a hand dial on the local control panel or using the keypad at the VFD in the panel room. From the local control panel, the screen can be run in a "jog reverse" mode to clear obstructions.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the screen shall be controlled at the local control panel.



**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the screen shall shutdown.

**Remote:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the screen is transferred to the PCS.

PCS:

**Software Interlock:**

If the influent channel level mismatch alarm (LI 201-0000) is active or both level instruments are out of service, the screen shall run at maximum speed.

If the upstream high-level switch (LSH 201-1300) is tripped, the screen shall run at maximum speed.

**On/Off Features**

**Manual:** The screen can be manually started and stopped from the PCS. The screen shall run at a constant operator adjustable speed.

**Auto:** The operator shall choose which barscreen channel is lead and which barscreen channels are lag. The ones not chosen as lead will revert to the lag channels. Channels will come online and barscreens shall run at variable speeds based on the influent channel level (LI-201-0001 or LI-201-0002). Operators will take barscreen channels offline from PCS.

**Lead Channel:** The channel will start online. The barscreen shall run between manufacturer recommended minimum and maximum speeds when the level in the influent channel is between ELV 0 ft and ELV 17 ft respectively. When either lag channel comes online the barscreen shall run at maximum speed for 5 minutes. After the timer is finished, the barscreen shall return to level based speed control.

The barscreen shall stop running five minutes after the channel is taken offline.

**Lag 1 Channel:** The channel will come online when the lead barscreen is running and the influent channel level is above ELV 17 ft for 1 minute. The barscreen shall run at a maximum speed for 5 minutes. After the timer is finished, the barscreen shall run between manufacturer recommended minimum and maximum speeds when the level in the influent channel is between ELV 0 ft and ELV 17 ft respectively.

The barscreen shall stop running five minutes after the channel is taken offline.

**Lag 2 Channel:** The channel will come online when both the lead and lag 1 barscreens are running and the influent channel level is above

ELV 17 ft for 1 minute. The barscreen shall run at a maximum speed for 5 minutes. After the timer is finished, the barscreen shall run between manufacturer recommended minimum and maximum speeds when the level in the influent channel is between ELV 0 ft and ELV 17 ft respectively.

The barscreen shall stop running five minutes after the channel is taken offline.

**Alarms / Monitoring:**

Local:

Running (MN)  
E-Stop (HS)  
Safety Pulled (XA)  
Fault (XA)  
Overload (MQ)

PCS:

Running Forward (MN)  
Fault (XA)  
E-Stop (HS)  
Speed Feedback  
H/O/A Switch (HS) is in "Auto"  
High Level Alarm (LAH)

**LOOP 201-2000 BARSCREEN 2**

**General:** Functionally identical to Loop 201-1000.

**LOOP 201-3000 BARSCREEN 3**

**General:** Functionally identical to Loop 201-1000.

**LOOP 202-2100 SCREW CONVEYOR 1**

**General:** The screw conveyor moves debris from the screen toward the washer compactors. The screw conveyor can push or pull screenings to either washer compactor where pushing is the primary direction of operation. Operation of the conveyor is at the local control panel or at PCS.

**Control:**

**Hardwired Interlocks:**

A high motor winding temperature switch (TSH) shall be wired to the starter. If the switch is tripped, the motor shall stop. The motor can be reset at the motor panel in the MCC room.

A zero speed switch (SSL) shall be wired to the starter. If the switch is tripped, the motor shall stop. The motor can be reset at the motor panel in the MCC room.

When the E-Stop pushbutton is pressed, the conveyor shall stop immediately. When the Emergency Pull Cord surrounding the two conveyors is pulled, the conveyor shall stop immediately.

#### Local:

The conveyor can be run in the East or West directions and stopped from the local control panel.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the conveyor shall be controlled at the local control panel.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the conveyor shall shutdown.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the conveyor is transferred to PCS.

#### PCS:

##### **Software Interlock:**

If none of the diverter gate limit switches (ZS 202-1101, 2101, 3101) indicate a diverter gate is directed towards the conveyor, the conveyor shall not run. A mismatch alarm shall be activated until at least one diverter gate has been manually switched to feed screenings to the conveyor. If a screen is running and no conveyor is running, an alarm shall be displayed at PCS to notify the operator.

If the zero-speed switch is tripped, the motor shall stop. The motor must be reset at PCS.

##### **On/Off Features**

**Manual:** The conveyor can be manually started and stopped, and the direction of the conveyor selected from the PCS.

**Auto:** If any of the screens are running, the conveyor shall run continuously. The conveyor will run for 3 minutes additional minutes after all screens have stopped.

#### **Alarms / Monitoring:**

##### Local:

Fault (XA)  
E-Stop (HS)

Running East (ME)  
Running West (MW)  
Zero Speed Alarm (SAL)  
Starter Overload Tripped (MQ)  
High Torque Alarm (WAH)  
Safety Pulled (XA)

PCS:

Fault (XA)  
E-Stop (HS)  
Running East (ME)  
Running West (MW)  
Mismatch Alarm (XA)  
H/O/A Switch (HS) is in "Auto"

**LOOP 202-2200      SCREW CONVEYOR 2**

**General:**      Functionally identical to Loop 202-2100.

**LOOP 202-3100      WASHER/COMPACTOR 1 KNIFE GATE 1**

**General:**      The knife gate is manually or automatically controlled to screenings to enter or bypass the washer/compactor from the actuator or PCS.

**Control:**

Local:

The gate can be manually opened or closed from the actuator.

Hand:      When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the gate will be controlled at the actuator.

Off:      When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the gate will be turned off.

Auto:      When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the gate shall be transferred to PCS.

PCS:

The operator will be able to control the influent gate in manual and automatic modes from the PCS.

Manual:      The gate can be manually opened or closed from the PCS.

Auto: The gate shall open when Screw Conveyor 2 is running.

**Alarms / Monitoring:**

Local:

Opened (ZSO)  
Closed (ZSC)  
Fault (XA)

PCS:

Opened (ZSO)  
Closed (ZSC)  
Fault (XA)  
H/O/A Switch (HS) is in "Auto"

**LOOP 202-3200 WASHER/COMPACTOR 1 KNIFE GATE 2**

**General:** Functionally identical to Loop 202-3100

**LOOP 202-3300 WASHER/COMPACTOR 2 KNIFE GATE 1**

**General:** Functionally identical to Loop 202-3100

**LOOP 202-3400 WASHER/COMPACTOR 2 KNIFE GATE 2**

**General:** Functionally identical to Loop 202-3100

**LOOP 202-4100 SCREENING WASHER/COMPACTOR 1**

**General:** The washer/compactor compresses the screenings before emptying them into a haul box. The washer/compactor can be controlled at the local control panel or at PCS.

**Control:**

**Hardwire Interlocks:**

A high motor winding temperature switch (TSH) shall be wired to the starter. If the switch is tripped the motor shall stop.

When the E-Stop pushbutton is pressed, the washer/compactor shall stop immediately.

Local:

The washer/compactor can be manually started and stopped to run forward at the control panel. The operator may also run the washer/compactor in “jog reverse” mode to clear any obstructions.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the washer/compactor shall be controlled at the local control panel.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the “Off” position, the washer/compactor shall shutdown.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the “Auto” position, control of the washer/compactor is transferred to PCS.

PCS:

**Software Interlock:**

Two knife gates will divert screenings from the conveyors to the washer/compactors. If no knife gate limit switches (ZS 202-3101, 3201) are tripped to indicate screenings will reach the washer/compactor, a mismatch alarm shall be activated and the washer/compactor shall not start. If a conveyor is pushing screenings towards a washer/compactor that is not running, an alarm shall be displayed on the PCS to notify the operator.

**On/Off Features:**

**Manual:** The washer/compactor can be manually started and stopped to run forward from the PCS.

**Auto:** If a conveyor is running, the washer/compactor shall run until the conveyor has stopped. The operator shall choose to run the washer/compactor in one of two modes: Batch Mode or Continuous Mode.

**Batch Mode:** The washer/compactor shall alternate running in forward and reverse for 15 minutes before discharging the compacted screenings.

**Continuous Mode:** The washer/compactor shall only run forward.

**Alarms / Monitoring:**

Local:

Fault (XA)  
E-Stop (HS)  
Overload (MQ)

Running (MN)

PCS:

E-Stop (HS)  
Fault (XA)  
Running (MN)  
H/O/A Switch (HS) is in "Auto"  
Mismatch Alarm (XA)

**LOOP 202-4200 SCREENING WASHER/COMPACTOR 2**

**General:** Functionally identical to Loop 202-4100.

**LOOP 201-4301 SCREENING WASHWATER PRESSURE AND FLOW**

**General:** Pressure transmitter and magnetic flow meter on the hot plant effluent water line primarily used for monitoring.

**Control:**

Local:

None.

PCS:

None.

**Alarms / Monitoring:**

Local:

None.

PCS:

Pressure Indication (PI)  
Flow Indication (FI)

**LOOP 201-4401 SCREENING WASHWATER PRESSURE AND FLOW**

**General:** Functionally identical to Loop 210-4301.

## **LOOP 201-1201    BARSCREEN 1 EFFLUENT SLIDE GATE (WEST)**

**General:**        The effluent slide gate is manually or automatically controlled to allow water to leave the screening channel from the actuator or PCS.

**Control:**

Local:

Hand:        When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the gate will be controlled at the actuator.

Off:         When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the gate will be turned off.

Auto:        When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the gate is transferred to PCS.

PCS:

Manual:     The gate can be manually opened and closed from the PCS.

Auto:        The effluent gate shall open when the channel comes online based on level control in Loop 201-1101.

When the channel is taken offline, the effluent gate shall close.

**Alarms / Monitoring:**

Local:

Opened (ZSO)

Closed (ZSC)

Fault (XA)

PCS:

Closed (ZSC)

Opened (ZSO)

Fault (XA)

H/O/A Switch (HS) is in "Auto"

## **LOOP 201-1202    BARSCREEN 1 EFFLUENT SLIDE GATE (EAST)**

**General:**        Functionally identical to Loop 201-1201.



**LOOP 201-2201 BARSCREEN 2 EFFLUENT SLIDE GATE (WEST)**

**General:** Functionally identical to Loop 201-1201.

**LOOP 201-2202 BARSCREEN 2 EFFLUENT SLIDE GATE (EAST)**

**General:** Functionally identical to Loop 201-1201.

**LOOP 201-3201 BARSCREEN 3 EFFLUENT SLIDE GATE (WEST)**

**General:** Functionally identical to Loop 201-1201.

**LOOP 201-3202 BARSCREEN 3 EFFLUENT SLIDE GATE (EAST)**

**General:** Functionally identical to Loop 201-1201.

**LOOP 210-1000 HIGH HIGH LEVEL FLOAT SWITCH**

**General:** High-high level float switch in the scum skimmer tank primarily used for alarming.

**Control:**

Local:

None.

PCS:

**Software Interlock:**

If the high-high level float switch is tripped, a high-highlevel alarm at PCS will notify the operator of a blockage in the overflow pipe and scum shall be manually diverted away from the scum tank.

**Alarms / Monitoring:**

Local:

None.

PCS:

High-High Level Alarm (LAHH)

## **LOOP 210-1000 SCUM SKIMMER TANK DISCHARGE FLOW**

**General:** Magnetic flow meter on the scum skimmer tank discharge primarily used for monitoring.

**Control:**

Local:

None.

PCS:

None.

**Alarms / Monitoring:**

Local:

None.

PCS:

Flow Indication (FI)

## **LOOP 210-1100 SCUM SKIMMER/COLLECTOR**

**General:** The skimmer pushes concentrated scum from the holding tank into the hopper. Operation of the skimmer is either at the local control panel or at PCS.

**Control:**

**Hardwired Interlocks:**

A high motor winding temperature switch (TSH) shall be wired to the starter. If the switch is tripped the motor shall stop.

When the E-Stop pushbutton is pressed, the skimmer shall stop immediately.

When the high-high level switch (LSHH) on the hopper is activated, the skimmer shall stop.

Local:

The skimmer can be started and stopped from the local scum concentration system control panel.

- Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the skimmer shall be controlled at the local control panel.
- Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the skimmer will be turned off.
- Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the skimmer is transferred to PCS.

PCS:

**Software Interlock:**

If the high-high level float switch in the scum hopper is tripped, the skimmer shall stop.

**On/Off Features:**

- Manual:** The skimmer can be manually started and stopped from the PCS.
- Auto:** The skimmer shall start when any of the scum slurry pumps start to run. The skimmer shall run for an additional 5 minutes after all scum slurry pumps stop.

**Alarms / Monitoring:**

Local:

Running (MN)  
Fault (XA)  
E-Stop (HS)  
Overload (MQ)

PCS:

Running (MN)  
Fault (XA)  
E-Stop (HS)  
H/O/A Switch (HS) is in "Auto"

**LOOP 210-2100 SCUM HOPPER MIXER**

**General:** The scum hopper holds a mixer, differential pressure level instrument, temperature sensor, high-high level float switch, and low-low level frequency shift tuning fork. The mixer distributes the concentrated scum in the hopper and is automatically controlled by the level and temperature in the hopper. Operation of the mixer can be at the local control panel or at PCS.

**Control:**

**Hardwire Interlocks:**

A high motor winding temperature switch (TSH) shall be wired to the starter. If the switch is tripped the motor shall turn off.

When the E-Stop pushbutton is pressed, the mixer shall stop immediately.

When the low-low level switch (LSLL) below the hopper is activated, the mixer shall stop.

#### Local:

The mixer can be manually started and stopped at the scum concentration system control panel.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the mixer shall be controlled at the local control panel.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the mixer shall shut down.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the mixer is transferred to PCS.

#### PCS:

##### **Software Interlocks:**

If the level in the hopper is below a manufacturer defined but engineer adjustable setpoint, the mixer shall stop.

If the temperature in the hopper is below a manufacturer defined but engineer adjustable setpoint, the mixer shall stop.

If the knife gate valve is not open when the mixer is running, a mismatch alarm will be displayed at the PCS.

##### **On/Off Features:**

**Manual:** The mixer can be manually started and stopped from the PCS.

**Auto:** The mixer is controlled by the level in the hopper. The mixer shall start and stop based on manufacturer defined but engineer adjustable setpoints.

##### **Alarms / Monitoring:**

#### Local:

Running (MN)

Fault (XA)

Overload (MQ)  
E-Stop (HS)

PCS:

Running (MN)  
Fault (XA)  
E-Stop (HS)  
H/O/A Switch (HS) is in "Auto"  
Level Indicator (LI)  
Level Low-Low Alarm (LALL)  
Level High-High Alarm (LAHH)  
Temperature Indicator (TI)  
Mismatch Alarm (XA)

**LOOP 210-3100 HOT WATER PUMP**

**General:** The hot water pump helps to maintain the temperature of the scum in the holding tank. Operation of the hot water pump is at the scum concentration system control panel or at PCS.

**Control:**

**Hardwired Interlocks:**

When the E-Stop pushbutton is pressed, the hot water pump shall shutdown.

Local:

The Hot Water Pump can be started and stopped from the local control panel.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the pump shall be controlled at the local control panel.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the pump shall shut down.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the pump is transferred to PCS.

PCS:

**Software Interlock:**

If the temperature in the scum hopper is above a manufacturer defined but engineer adjustable setpoint, a high-high temperature alarm will be activated and the pump shall turn off.

If the low-low level switch in the scum hopper is tripped, the pump shall turn off.

If the pressure in the hot water loop is below a manufacturer defined setpoint, a low-pressure alarm will be activated and the pump shall turn off.

### **On/Off Features**

**Manual:** The operator shall choose to run the entire scum heating system manually from PCS. This includes the hot water pump and hot water heater.

**Auto:** The entire scum heating system (heater and pump) shall be controlled by the level and temperature in the hopper. The scum heating system shall turn on when the level and temperature reach manufacturer defined but engineer adjustable setpoints. The scum heating system shall turn off when the level or temperature in the hopper reach manufacturer defined but engineer adjustable setpoints.

If the temperature sensor in the hopper is Out of Service, the scum heating system will be controlled by the temperature sensor on the hot water skid.

### **Alarms / Monitoring:**

#### Local:

Hopper Temperature Indication (TIT)  
Hot Water Skid Temperature Indication (TIT)  
Fault (XA)  
Overload (MQ)  
E-Stop (HS)  
Running (MN)

#### PCS:

Hopper Temperature Indication (TI)  
Hot Water Skid Temperature Indication (TI)  
Running (MN)  
Temperature High-High Alarm (TAHH)  
Low-Low Level Alarm (LALL)  
E-Stop (HS)  
H/O/A Switch (HS) is in "Auto"

### **LOOP 210-3100 HOT WATER PUMP DISCHARGE PRESSURE**

**General:** Pressure transmitter on the hot water pump discharge primarily used for monitoring and shutdown of the hot water pump.

#### **Control:**

#### Local:

None.

PCS:

None.

**Alarms / Monitoring:**

Local:

None.

PCS:

Pressure Indication (PI)  
Low Loop Pressure (PAL)

**LOOP 210-3200 HOT WATER HEATER**

**General:** The heater helps to maintain the temperature of the scum in the holding tank. Operation of the hot water heater is at the scum concentration system control panel or at PCS.

**Control:**

Local:

The Hot Water Heater can be started and stopped from the local control panel.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the heater shall be controlled at the local control panel.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the heater shall shut down.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the heater is transferred to PCS.

PCS:

**Software Interlock:**

If the temperature in the scum hopper is above a manufacturer defined but engineer adjustable setpoint, a high-high temperature alarm will be activated, and the heater shall turn off.

If the low-low level in the scum hopper is tripped, the heater shall turn off.

If the hot water pump is not running, the heater shall not run.

### **On/Off Features**

**Manual:** The operator shall choose to run the entire scum heating system manually from PCS. This includes the hot water pump and hot water heater.

**Auto:** The entire scum heating system (pump and heater) shall be controlled by the level and temperature in the hopper. The scum heating system shall turn on when the level and temperature reach manufacturer defined but engineer adjustable setpoints. The scum heating system shall turn off when the level or the temperature reach manufacturer defined but engineer adjustable setpoints.

If the temperature sensor in the hopper is set to Out of Service, the scum heating system will be controlled by the temperature sensor on the hot water skid.

### **Alarms / Monitoring:**

#### Local:

Hopper Temperature Indication (TIT)  
Hot Water Skid Temperature Indication (TIT)  
Running (MN)

#### PCS:

Hopper Temperature Indication (TI)  
Hot Water Skid Temperature Indication (TI)  
Running (MN)  
Temperature High-High Alarm (TAHH)  
Low-Low Level Alarm (LALL)  
H/O/A Switch (HS) is in "Auto"

### **LOOP 210-4000 CONCENTRATED SCUM PUMP**

**General:** The concentrated scum pump is used to discharge scum from the hopper to the grit bins or to recirculate scum into the hopper. Operation of the pump is either at the scum concentration system local control panel or at the PCS.

#### **Control:**

#### **Hardwired Interlocks:**



A high motor winding temperature switch (TSH) shall be wired to the drive. If the switch is tripped, the drive will turn off. The drive can be reset at the local control panel.

Operators can set the high-stator temperature setpoint from the controller in the Scum System Local Control Panel. When the high stator temperature alarm is activated, the concentrated scum pump shall stop. The high stator temperature setpoint will be manufacturer defined.

When the limit switch on the knife gate is not tripped to indicate it is open, the concentrated scum pump shall not run.

When the high discharge pressure switch (PSH) is tripped, the concentrated scum pump shall stop.

When the E-Stop pushbutton is pressed, the pump shall stop immediately.

When the high-high level switch (LSHH) on the hopper is activated, the concentrated scum pump shall start.

When the low-low level switch (LSLL) below the hopper is activated, the concentrated scum pump shall stop.

#### Local:

The pump can be run at a constant speed and stopped from the local control panel.

- Hand: When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the pump shall be controlled at the local control panel.
- Off: When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the pump shall shutdown.
- Auto: When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the pump is transferred to the PCS.

#### PCS:

##### **Software Interlock:**

If the low-low level switch in the scum hopper is tripped, the pump shall stop.

If the temperature in the hopper is below a manufacturer defined but engineer adjustable setpoint, the pump shall stop.

##### **On/Off Features:**

Manual: The pump can be manually started and stopped from the PCS.

**Auto:** The pump shall be controlled by the level in the holding tank and can operate in one of two modes: “Feed Mode” and “Feed Plus Recirc Mode”:

**Feed Mode:** The pump shall start and stop based on manufacturer defined but engineer adjustable setpoints.

**Recirc Mode:** The pump shall start and stop based on manufacturer defined but engineer adjustable setpoints.

**Feed Plus Recirc Mode:** The pump shall run continuously.

**Alarms / Monitoring:**

Local:

High Stator Temperature (TAH)  
E-Stop (HS)  
Running (MN)  
Fault (XA)  
Overload (MQ)  
High Pressure (PAH)

PCS:

Running (MN)  
Fault (XA)  
High Pressure (PAH)  
High Stator Temperature (TAH)  
E-Stop (HS)  
H/O/A Switch (HS) is in “Auto”

**LOOP 210-4200 CONCENTRATED SCUM PUMP DISCHARGE TEMPERATURE**

**General:** Temperature transmitter on the concentrated scum pump discharge primarily used for monitoring.

**Control:**

Local:

None.

PCS:

None.

**Alarms / Monitoring:**

Local:

None.

PCS:

Temperature Indication (TI)

**LOOP 210-4300 CONCENTRATED SCUM PUMP MOTORIZED VALVE 1**

**General:** The solenoid valve is manually or automatically controlled to divert scum to the hopper or the grit bins from the actuator or PCS.

**Control:**

Local:

The valve can be manually opened or closed from the actuator.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the valve will be controlled at the actuator.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the valve will be turned off.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the valve shall be transferred to PCS.

PCS:

The operator will be able to control the valve in manual and automatic modes from the PCS.

**Manual:** The valve can be manually opened or closed from the PCS.

**Auto:** When the Concentrated Scum Pump is placed in "Feed Mode" the valve shall close. When the Concentrated Scum Pump is placed in "Recirc Mode" or "Feed Plus Recirc Mode" the valve shall open.

**Alarms / Monitoring:**

Local:

Opened (ZSO)

Closed (ZSC)

Fault (XA)

PCS:

Opened (ZSO)  
Closed (ZSC)  
Fault (XA)  
H/O/A Switch (HS) is in "Auto"

## **LOOP 210-4500 CONCENTRATED SCUM PUMP MOTORIZED VALVE 2**

**General:** The solenoid valve is manually or automatically controlled to divert scum to the West Screenings and Grit Bin from the actuator or PCS.

**Control:**

Local:

The valve can be manually opened or closed from the actuator.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the valve will be controlled at the actuator.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the valve will be turned off.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the valve shall be transferred to PCS.

PCS:

The operator will be able to control the valve in manual and automatic modes from the PCS.

**Manual:** The valve can be manually opened or closed from the PCS.

**Auto:** The valve can be enabled from the PCS when the west screenings and grit bin is available. When the Concentrated Scum Pump is placed in "Feed Mode" or "Feed Plus Recirc Mode" the valve shall open. When the Concentrated Scum Pump is placed in "Recirc Mode" the valve shall close.

**Alarms / Monitoring:**

Local:

Opened (ZSO)  
Closed (ZSC)  
Fault (XA)

PCS:

Opened (ZSO)

Closed (ZSC)  
Fault (XA)  
H/O/A Switch (HS) is in "Auto"

### **LOOP 210-4600 CONCENTRATED SCUM PUMP MOTORIZED VALVE 3**

**General:** The solenoid valve is manually or automatically controlled to divert scum to the East Screenings and Grit Bin from the actuator or PCS.

**Control:**

Local:

The valve can be manually opened or closed from the actuator.

**Hand:** When the Hand/Off/Auto selector switch (HS) is in the "Hand" position, the valve will be controlled at the actuator.

**Off:** When the Hand/Off/Auto selector switch (HS) is in the "Off" position, the valve will be turned off.

**Auto:** When the Hand/Off/Auto selector switch (HS) is in the "Auto" position, control of the valve shall be transferred to PCS.

PCS:

The operator will be able to control the valve in manual and automatic modes from the PCS.

**Manual:** The valve can be manually opened or closed from the PCS.

**Auto:** The valve can be enabled from the PCS when the east screenings and grit bin is available. When the Concentrated Scum Pump is placed in "Feed Mode" or "Feed Plus Recirc Mode" the valve shall open. When the Concentrated Scum Pump is placed in "Recirc Mode" the valve shall close

**Alarms / Monitoring:**

Local:

Opened (ZSO)  
Closed (ZSC)  
Fault (XA)

PCS:

Opened (ZSO)  
Closed (ZSC)

Fault (XA)  
H/O/A Switch (HS) is in "Auto"

### **LOOP 100-1000 HVAC PANEL PTB-ATC-01**

**General:** The HVAC panel monitors ventilation status, the makeup air unit and two exhaust fans that service the preliminary treatment building, and the variable dampers at the gravity thickeners.

**Control:**

None.

**Alarms / Monitoring:**

Local:

MAU-01 Running (MN)  
MAU-01 Burner On (MN)  
MAU-01 Low Temperature (TAL)  
MAU-01 Ventilation Failure (XA)  
MAU-01 Smoke Detection (XA)  
Dirty Filter (XA)  
Low Temperature (XA)  
FAF-01A Running (MN)  
FAF-01A Ventilation Failure (XA)  
FAF-01A Smoke Detection (XA)  
FAF-01B Running (MN)  
FAF-01B Ventilation Failure (XA)  
FAF-01B Smoke Detection (XA)  
Screen Room Ventilation Failure (XA)

PCS:

MAU-01 Ventilation Failure (XA)  
FAF-01A Ventilation Failure (XA)  
FAF-01B Ventilation Failure (XA)  
Screen Room Ventilation Failure (XA)  
Gravity Thickener 1 Damper Status (ZS)  
Gravity Thickener 2 Damper Status (ZS)

### **LOOPS 100-2100, 21X1, 21X2, 21X3, 21X4 PTB GAS DETECTION**

**General:** LEL, CO, H2S and O2 gases are measured by sampled draw pumps and gas analyzers throughout the Preliminary Treatment Building.

**Control:**

None.

**Alarms / Monitoring:**

Local:

LEL Gas (AIT)  
CO Gas (AIT)  
O2 Gas (AIT)  
H2S Gas (AIT)  
General Gas Horn Alarm (XA)  
General Gas Beacon Alarm (XA)

PCS:

LEL Gas (AI)  
CO Gas (AI)  
O2 Gas (AI)  
H2S Gas (AI)  
LEL Gas Alarm (XA)  
CO Gas Alarm (XA)  
O2 Gas Alarm (XA)  
H2S Gas Alarm (XA)  
Sample Draw Pump Flow Fault (XA)  
Common Alarm (XA)

**LOOPS 100-2200, 22X1, 22X2, 22X3, 22X4 GRAVITY THICKENERS GAS DETECTION**

**General:** LEL, CO, H2S and O2 gases are measured by sampled draw pumps and gas analyzers in the Gravity Thickeners. Functionally identical to loops 100-2100, 21X1, 21X2, 21X3, and 21X4.

END OF SECTION 406196





## SECTION 406733 - PANEL WIRING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes requirements for internal wiring of control panels and consoles.

#### 1.3 ACTION SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

### PART 2 - PRODUCTS

#### 2.1 CONTROL PANEL - INTERNAL CONSTRUCTION

- A. Internal Electrical Wiring:
  1. Provide stranded, type MTW interconnecting wiring with 600-volt insulation rated for not less than 90 degrees Celsius. Segregate wiring for systems operating at voltages of 120 VAC from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Develop panel layout such that technicians shall have complete access to lower voltage wiring systems without direct exposure to 120 VAC or higher voltages.
  2. For power distribution wiring on the line side of fuses or breakers, use 12 AWG minimum. For control wiring on the secondary side of fuses, use 16 AWG minimum. Utilize 18 AWG shielded, twisted pair cable insulated for not less than 600 volts for electronic analog circuits.
  3. Cover power distribution blocks with protective guards to meet "finger-safe" requirements of IP20.
  4. Route power and low voltage DC wiring systems in separate wireways. Cross different system wires at right angles. Separate different system wires routed parallel to each other by at least 6-inches. Terminate different wiring systems on separate terminal blocks. Do not fill wiring troughs to more than 60 percent visible fill.
  5. Terminations:
    - a. Terminate wiring onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable.

- 1) Multi-level terminal blocks or strips are not acceptable.
  - b. Arrange terminal blocks in vertical rows and separated into groups (power, AC control, DC signal). Provide each group of terminal blocks with a minimum of 25 percent spares.
  - c. Use compression type, fused, unfused, or switched terminal blocks. Use two terminals per point for discrete inputs and outputs (DI and DO) with adjacent terminal assignments. Wire all active and spare PLC and controller points to terminal blocks.
  - d. Use three terminals per point for analog inputs and outputs (AI and AO) per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. Wire all active and spare PLC and controller points to terminal blocks.
  - e. Use sleeve-type wire and tube markers with heat impressed letters and numbers.
  - f. Use only one side of a terminal block row for internal wiring. Field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free-standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.
  - g. Isolate circuit power from the SCADA cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. Use an Allen Bradley Model 1492-H7 or equal. One isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.
  - h. Isolate all PLC discrete outputs to the field with an isolating fuse switch terminal block with a flip cover and a neon blown fuse indicator. Use an Allen Bradley 1492-H4 or equal.
6. Clearly identify wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection as such.
  7. Wiring shall be clearly tagged and color coded. Tag numbers and color coding shall correspond to panel wiring diagrams and loop drawings prepared by the PCSS. Power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. Color coding scheme shall be in accordance with UL 508a.
  8. Provide surge protectors on all incoming power supply lines at each panel per requirements of Section 407856 "Isolators, Intrinsic Safety Barriers, and Surge Suppressors."
  9. Each field instrument furnished under Division 40 and shown on the Drawings as deriving input power from the control panels shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication. Instruments requiring 120VAC power shall be powered as shown on the drawings.
  10. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. Side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.
  11. Each panel shall have a single tube, LED light fixture, 20 Watt in size (minimum), mounted internally to the ceiling of the panel. Light fixture shall be switched and shall be complete with the lamp.
  12. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate

- cover. Convenience receptacle shall not be powered from a UPS and shall be protected by a dedicated fuse or circuit breaker.
13. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.
  14. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
  15. Each panel shall have control, signal, and communication line surge suppression in accordance with Section 40 78 56.
  16. Each panel shall be provided with a circuit breaker to interrupt incoming power.
  17. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 26.
- B. Relays not provided under Division 26 and required for properly completing the control function specified in Division 40, Division 26 or shown on the Drawings shall be provided under this Section.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

END OF SECTION 406733



## SECTION 407000 - INSTRUMENTATION FOR PROCESS SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.2 SUMMARY

- A. Section includes the general requirements for providing and servicing PCSS provided instruments.
- B. Related Requirements:
  - 1. Refer to individual instrument specifications.

#### 1.3 DEFINITIONS

- A. PCSS: Process Control System Supplier as defined in Section 40 61 00 "Process Control and Enterprise Management System General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Submit complete documentation of all field instruments using ISA-TR20.00.01-2001 (updated in 2004-2006) data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment. The list shall be sorted by Loop Number.
- B. Submit separate data sheets for each instrument type including:
  - 1. Plant Equipment Number and ISA tag number per the Drawings.
  - 2. Product (item) name used herein and on the Drawings.
  - 3. Manufacturer's complete model number.
  - 4. Location of the device.
  - 5. Input - output characteristics.
  - 6. Range, size, and graduations in engineering units.
  - 7. Include construction details, material descriptions, dimensions of individual components and profiles.
  - 8. Instrument or control device sizing calculations where applicable.
  - 9. Indicate which instruments will be provided with certified calibration data (i.e., all flow metering devices) as part of O&M manual.

10. Include rated capacities, operating characteristics, electrical characteristics and furnished specialties, accessories, and connection size and type.
11. Indicate which instruments will be provided with manufacturer's maintenance services if specified.

C. Instrument Vendor Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of instrument.
4. Include diagrams for power, signal, and control wiring.

D. Submit catalog cuts for all instruments. Submit descriptive literature for each hardware component, which fully describes the units being provided.

E. Submit index and data sheets in electronic format as well as hard copies on 8-1/2" x 11" formats. Electronic format shall be in Microsoft Excel or Word. Submit electronic copy on DVD disk.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

#### 1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding closeout submittals for instruments.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for PCSS requirements regarding submission of maintenance materials

#### 1.8 QUALITY ASSURANCE

A. Refer to individual instrument specifications for quality assurance requirements as well as which specific instruments require manufacturer's start-up and training services.

## PART 2 - PRODUCTS

### 2.1 INSTRUMENT TAGS

- A. A permanent stainless steel firmly attached and permanently and indelibly marked with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section and related sections. Equipment shall be tagged before shipping to the site.
- B. Provide 1/8-inch by 3/8-inch, Type 316 stainless-steel button head machine screws.
- C. All supplied instrument transmitters and instrument transmitter elements shall have a stainless-steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via stainless-steel chain or stainless-steel wire (24 gauge min) to a non-removable part of the device. The tag size shall be a minimum of 1 inch H x 3 inches W. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-inch high alphanumeric characters.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. See execution requirements in Section 406100 "Process Control and Enterprise Management Systems General Provisions."
- B. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

### 3.2 INSTALLATION

- A. See installation requirements in individual specification Sections.

END OF SECTION 407000





## Instrumentation List

Drawing No.	ISA Tagname	Proc. No.	Loop No.	Description	Div	Size	Range	Units	Power	Location	Spec. Ref.	Installation Detail
I-2	LSHH	201	0000	Float Level Switch	40		ELV 17.0	FT	None	PTB Influent	407276-2.1	Detail-K
I-2	LE/LIT	201	0001	Radar Level Element / Transmitter	40		0-10	FT	120VAC	PTB Influent	407223	Detail-C
I-2	LE/LIT	201	0002	Radar Level Element / Transmitter	40		0-10	FT	120VAC	PTB Influent	407223	Detail-C
I-2	LSH	201	1300	Float Level Switch	40		ELV 17.0	FT	None	Screening Channel 1	407276-2.1	Detail-F
I-2	LSH	201	2300	Float Level Switch	40		ELV 17.0	FT	None	Screening Channel 2	407276-2.1	Detail-F
I-2	LSH	201	3300	Float Level Switch	40		ELV 17.0	FT	None	Screening Channel 3	407276-2.1	Detail-F
I-2	FE/FIT	202	4301	Magnetic Flow Tube / Flow Transmitter	40	2.5"	0-250*	GPM	120VAC	Screening Washwater 1	407113	Detail-H
I-2	PI	202	4301	Pressure Gauge	40		0-100	PSIG	None	Screening Washwater 1	407313	Detail-B
I-2	PT	202	4301	Pressure Transmitter	40		0-100	PSIG	Loop Powered	Screening Washwater 1	407326	Detail-B
I-2	PI	202	4302	Pressure Gauge	40		0-100	PSIG	None	Screening Washwater 2	407313	Detail-B
I-2	PI	202	4303	Pressure Gauge	40		0-100	PSIG	None	Screening Washwater 1	407313	Detail-B
I-2	FE/FIT	202	4401	Magnetic Flow Tube / Flow Transmitter	40	4"	0-500*	GPM	120VAC	Screening Washwater 2	407113	Detail-H
I-2	PT	202	4401	Pressure Transmitter	40		0-100	PSIG	Loop Powered	Screening Washwater 2	407326	Detail-B
I-2	PI	202	4401	Pressure Gauge	40		0-100	PSIG	None	Screening Washwater 2	407313	Detail-B
I-2	PI	202	4402	Pressure Gauge	40		0-100	PSIG	None	Screening Washwater 1	407313	Detail-B
I-2	PI	202	4403	Pressure Gauge	40		0-100	PSIG	None	Screening Washwater 2	407313	Detail-B
I-3	LSHH	210	1000	Float Level Switch	46		MFR Defined	FT	None	Scum Skimmer Tank	407276-2.1	Detail-F
I-3	FE/FIT	210	1000	Magnetic Flow Tube / Flow Transmitter	40	6"	0-200	GPM	120VAC	Scum Skimmer Tank Discharge	407113	Detail-H
I-3	LE/LIT	210	2000	Level (Differential Pressure) Transmitter	46		MFR Defined	FT	Loop Powered	Scum Hopper Level	407243	Detail-E
I-3	LSHH	210	2000	Float Level Switch	46		MFR Defined	FT	None	Scum Hopper	407276-2.1	Detail-F
I-3	LSLL	210	2000	Tuning Fork Level Switch	46		MFR Defined	FT	120VAC	Scum Hopper	407276-2.2	Detail-D
I-3	TE/TIT	210	2000	Temperature Transmitter	46		MFR Defined	DEG F	Loop Powered	Scum Hopper	407463	Detail-G
I-3	TE/TIT	210	3000	Temperature Transmitter	40		0-200	DEG F	Loop Powered	Hot Water Skid	407463	Detail-G
I-3	PI	210	3002	Pressure Gauge	40		0-100	PSIG	None	County Water Supply	407313	Detail-B
I-3	PT	210	3101	Pressure Transmitter	46		MFR Defined	PSIG	Loop Powered	Hot Water Skid	407326	Detail-B
I-3	PI	210	4200	Pressure Gauge	46		MFR Defined	PSIG	None	Concentrated Scum	407313	Detail-B
I-3	PSH	210	4200	Pressure Switch	46		MFR Defined	PSIG	None	Concentrated Scum	407336	Detail-A
I-3	TE/TIT	210	4200	Temperature Transmitter	40		0-200	DEG F	Loop Powered	Concentrated Scum	407463	Detail-G

Instrumentation List

\* contractor to confirm per verification of PEW and PEW HOT system capacities

12/18/2020

Drawing No.	ISA Tagname	Proc. No.	Loop No.	Description	Div	Size	Range	Units	Power	Location	Spec. Ref.	Installation Detail
I-4	AE/AIT	100	2111	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	First Floor Screen Room	407623	Detail-J
I-4	AE/AIT	100	2121	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	First Floor Screen Room	407623	Detail-J
I-4	AE/AIT	100	2122	Carbon Monoxide (CO) Analyzer	40		0-100	PPM	Loop Powered	First Floor Screen Room	407643	Detail-I
I-4	AE/AIT	100	2123	Oxygen (O2) Analyzer	40		0-100	%	Loop Powered	First Floor Screen Room	407613	Detail-I
I-4	AE/AIT	100	2124	Hydrogen Sulfide (H2S) Analyzer	40		0-100	PPM	Loop Powered	First Floor Screen Room	407633	Detail-I
I-4	AE/AIT	100	2131	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	First Floor Screen Room	407623	Detail-J
I-4	AE/AIT	100	2141	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	Second Floor Screen Room	407623	Detail-J
I-4	AE/AIT	100	2151	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	Second Floor Screen Room	407623	Detail-J
I-4	AE/AIT	100	2152	Carbon Monoxide (CO) Analyzer	40		0-100	PPM	Loop Powered	Second Floor Screen Room	407643	Detail-I
I-4	AE/AIT	100	2153	Oxygen (O2) Analyzer	40		0-100	%	Loop Powered	Second Floor Screen Room	407613	Detail-I
I-4	AE/AIT	100	2154	Hydrogen Sulfide (H2S) Analyzer	40		0-100	PPM	Loop Powered	Second Floor Screen Room	407633	Detail-I
I-4	AE/AIT	100	2161	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	Second Floor Screen Room	407623	Detail-J
I-4	AE/AIT	100	2171	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	Corridor	407623	Detail-I
I-4	AE/AIT	100	2172	Carbon Monoxide (CO) Analyzer	40		0-100	PPM	Loop Powered	Corridor	407643	Detail-I
I-4	AE/AIT	100	2181	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	Corridor	407623	Detail-I
I-4	AE/AIT	100	2182	Carbon Monoxide (CO) Analyzer	40		0-100	PPM	Loop Powered	Corridor	407643	Detail-I
I-4	AE/AIT	100	2191	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	MCC Room	407623	Detail-I
I-4	AE/AIT	100	2211	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	Gravity Thickener 1	407623	Detail-J
I-4	AE/AIT	100	2212	Carbon Monoxide (CO) Analyzer	40		0-100	PPM	Loop Powered	Gravity Thickener 1	407643	Detail-I
I-4	AE/AIT	100	2213	Oxygen (O2) Analyzer	40		0-100	%	Loop Powered	Gravity Thickener 1	407613	Detail-I
I-4	AE/AIT	100	2214	Hydrogen Sulfide (H2S) Analyzer	40		0-100	PPM	Loop Powered	Gravity Thickener 1	407633	Detail-I
I-4	AE/AIT	100	2221	Combustible Gas (LEL) Analyzer	40		0-100	% LEL	Loop Powered	Gravity Thickener 2	407623	Detail-J
I-4	AE/AIT	100	2222	Carbon Monoxide (CO) Analyzer	40		0-100	PPM	Loop Powered	Gravity Thickener 2	407643	Detail-I
I-4	AE/AIT	100	2223	Oxygen (O2) Analyzer	40		0-100	%	Loop Powered	Gravity Thickener 2	407613	Detail-I
I-4	AE/AIT	100	2224	Hydrogen Sulfide (H2S) Analyzer	40		0-100	PPM	Loop Powered	Gravity Thickener 2	407633	Detail-I

## SECTION 407113 - MAGNETIC FLOW METERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes magnetic flow meters.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each Flow Meter, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For Magnetic Flow Meters.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.10 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.11 WARRANTY

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Furnish sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, interconnecting cables, and unit conversions and algorithms as required for application.

### 2.2 MAGNETIC FLOW METERS

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. ABB Instrumentation;

- b. Endress+Hauser;
  - c. Rosemount;
  - d. Substitutions: Not Permitted.
- B. Description: Low-frequency, electromagnetic induction-type flow meter, producing a linear signal directly proportional to flow rate, consisting of flow tube, signal cable, and transmitter.
- C. Performance and Design Criteria:
  - 1. Design: According to AWWA M33.
- D. Flow Rate Range: See appendix A: Instrument List.
- E. Size: As indicated on Drawings.
- F. Flow Tubes:
  - 1. Body Material: Type 304 stainless steel
  - 2. Liner: Polyurethane or composite elastomer.
  - 3. Length: As indicated on Drawings.
  - 4. End Connections: Flanged, ANSI 150lb or DIN PN 16 carbon steel.
- G. Electrodes:
  - 1. Type 316L stainless steel.
  - 2. Self-cleaning.
- H. Accuracy: Plus or minus 0.5 percent of actual flow rate over a 30:1 range, within velocity limits of 0.1-10.0 ft/sec.
- I. Provide adjustment for zero and span.
- J. Accessories:
  - 1. Option: Integral level compensation to allow accurate measurement of flow in pipes between 10 percent to 100 percent fill level.
  - 2. Option: Rated for hazardous area, Class I, Division 2.
  - 3. Furnish cable between transmitter and receiver.
  - 4. Furnish grounding rings, wires, and gaskets as recommended by the manufacturer. All materials must be suitable for the process and surrounding pipe.

## 2.3 TRANSMITTERS

- A. Manufacturer: Same manufacturer as meter.
- B. Transmitter Output:
  - 1. 4-20 mA DC HART Analog Signal.
- C. Control Power:

1. 120-V ac, single phase, 60 Hz.
2. Furnish local transformers as required.

D. Mounting:

1. Mounting: Remote, up to 300 feet from flow meter.

E. Accessories:

1. Current signal output simulation.
2. Empty pipe detection.
3. Self-diagnostics.
4. Optional: Field validation package that compares current operational status to a factory baseline to verify meter performance. Furnish field verification hardware and software tools as required, and compatible transmitters.
5. Automatic zero adjustment.
6. Signal Cable: Provided by flow meter manufacturer.

## 2.4 SOURCE QUALITY CONTROL

A. Section 014000 "Quality Requirements": Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of meters according to AWWA M6.

C. Owner Inspection:

1. Make completed flow meter available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

D. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

E. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging specifications.

### 3.5 FIELD QUALITY CONTROL

- A. Magnetic flow meter will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407113





## SECTION 407223 - RADAR LEVEL METERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes radar level meters.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each Level Sensor, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For Radar Level Sensors.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.9 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## PART 2 - PRODUCTS

### 2.1 NON- CONTACT RADAR-LEVEL MEASUREMENT DEVICE

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Endress Hauser
    - b. Rosemount
    - c. Magnetrol
    - d. Substitutions: Not Permitted.
- B. Type:
  - 1. Low 6.3 GHz radar frequency for continuous level measurement of liquid, slurry and sludge processes in storage vessels that may be turbulent, have heavy vapors and foaming conditions in nominal pressure and temperature.
- C. Function/Performance:
  - 1. Measuring Range: Range suitable for the installation indicated,

2. Accuracy: Plus or minus 0.32 inches.
3. Operating Temperature: -40 to 149 degrees F.
4. Output: Isolated 4-20 mA DC HART Analog Signal. Display: Digital indicator displaying level or volume in engineering units or percent, as indicated on the Drawings or in the Instrument Device Schedule.
5. Diagnostics: On-screen instructions and display of self-diagnostics.

D. Physical:

1. Antenna: PVDF, Type 316 stainless steel, Hastelloy C or other material depending upon its compatibility to the process in which it is measuring. Provide integral antenna with transmitter.
2. Provide with a minimum Class 150 pound (DN 80, PN16) mounting flange to match vessel flange size, material and class when mounted on vessel.
3. NEMA 4X (IP66) housing. Where the instrument is installed in a hazardous area, provide explosion-proof housing, approved for Class I, Division 1, Groups C and D installation and certified for installation of the antenna in a Class I, Division 1, Groups C and D (Zone 0) environment.
4. Power Requirements: 24 VDC loop power.
5. Remote Display: Digital indicator displaying level or volume in engineering units or percent, as indicated on the Drawings or in the Instrument List. Display unit used to remotely program the transmitter.

E. Accessories Required:

1. Where required for calibration/programming, provide a hand-held programmer.

F. Manufacturer Start-up and Training services:

1. Provide manufacturer's start-up and training services as specified in the start-up and training services paragraph.

## 2.2 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.

- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.5 FIELD QUALITY CONTROL

- A. Radar level meters will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407223

## SECTION 407243 - PRESSURE AND DIFFERENTIAL PRESSURE TYPE LEVEL METERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes differential pressure type level meters.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each Hydrostatic Level Meter, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For Hydrostatic Level Meters.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.9 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.10 WARRANTY

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 FLANGED MOUNTED DIFFERENTIAL PRESSURE (LEVEL) TRANSMITTERS (OPEN TO ATMOSPHERE TANK)

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. ABB.
    - b. Foxboro.
    - c. Model 3051L by Rosemount.
    - d. Substitutions: Not Permitted.
- B. Type:
  - 1. Flanged mounted, microprocessor based, intelligent type.

C. Function/Performance:

1. Range: Standard range of the manufacturer closest to the pressure range to be metered.
2. Accuracy: 0.075 percent of span.
3. Operating Temperature: -4 to 176 degrees F.
4. Temperature Effect: Combined temperature effects less than 0.2 percent of maximum span per -2 degrees F temperature change.
5. Output: 4-20 mA DC linear with pressure or level with HART protocol. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.
6. Stability: 0.05 percent of upper range limit for 1 year.

D. Diagnostics:

1. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
2. Simulation capability for inputs and loop outputs.
3. Test terminals available to ease connection for test equipment without opening the loop.
4. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
5. Run-time clock available to determine usage for warranty purposes. Five year warranty on this clock reading is included.
6. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.

E. Physical:

1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (Ex d IIC T5).
2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be Type 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
3. Flange: Flange on low side shall be ANSI 3-inch, 150 lb. (DN 80, PN 25 or 40) carbon steel. High side left open to atmosphere.
4. Power supply shall be 24 VDC loop power.
5. Sensor Fill Fluid: Silicone.

F. Accessories Required:

1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.
2. Provide capillary seals and capillary filled cable for the low side flange connection suitable to the process liquid being metered if transmitter is mounted above or below flanged connection. Seal filled with silicone.

## 2.2 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to drawings for tagging designation.

### 3.5 FIELD QUALITY CONTROL

- A. Differential pressure type level meters will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.



END OF SECTION 407243



## SECTION 407276 - LEVEL SWITCHES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes level switches.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
  - 2. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.10 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 FLOAT SWITCHES

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Contegra FS 90.
    - b. Gems Sensor
    - c. Flowline
    - d. Substitutions: Not Permitted.
- B. Type:
  - 1. Mercury free ball float switch.
- C. Function/Performance:
  - 1. Differential: Less than 8 inches.

2. Type of Switch: SPDT snap switch
3. Switch Rating: 1 amps at 120 VAC or 100 VA @ 120 VAC.

D. Physical:

1. Float: Type 316 stainless steel, Teflon or non-stick coating, minimum 5 in diameter.
2. Totally encapsulated switch.
3. Cable shall be heavy-duty, PVC or equivalent jacketed integral to float.

E. Options/Accessories Required:

1. Provide stainless-steel hardware.
2. Lead wire shall be a waterproof cable of sufficient length so that no splice or junction box is required in the vault.
3. Provide cast-aluminum weatherproof junction box outside the sump pit with terminals for all floats and tapped as required for conduit connections.
4. Provide mounting equipment as shown on the drawings.

## 2.2 TUNING FORK VIBRATION LEVEL SWITCH

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
  - a. ABB.
  - b. Rosemount.
  - c. Siemens Automation Technology; Siemens AG Industry Sector.
  - d. Substitutions: Not Permitted.

B. Type:

1. Housing: Heavy duty cast aluminum NEMA 4X with 120 VAC contact outputs. Where hazardous areas are indicated, provide explosion-proof housing, approved for Class I, Division 1, Groups C and D installation and certified for installation of the antenna in a Class I, Division 1, Groups C and D (Zone 0) environment. Locate the housing/electronics outside tank, channel or containment area

C. Operation: Purpose - To detect liquid at a predetermined level with contact between the tuning fork area. Operating Principle -The tuning fork is piezoelectrically energized and vibrates at its mechanical resonance. The vibration frequency changes when the tuning fork is covered by the medium. This change is detected by the integrated oscillator and converted into a switching command and actuate an alarm.

D. Functional: Output: DPDT Contacts, 7 Amps, 120 VAC.

E. Power Requirements: 120 VAC, 60 Hz.

F. Physical: Probe - PFA, or Type 316 SS; Mounting - 2 inch, 150 pound flange or NPT fitting. Probe length to suit activation point. Provide flanges for probes mounted on tanks. Provide

correct length probes from housing/electronics to active right below overflow of the tank, channel or containment area. The correct lengths determined during the construction phase.

- G. Performance: Sensitivity - response time of 2 seconds and a repeatability of 0.004 inch

## PART 1 - EXECUTION

### 1.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

### 1.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 1.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 1.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations

### 1.5 FIELD QUALITY CONTROL

- A. Level switches will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 1.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the

instrument. Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407276





## SECTION 407313 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes pressure gauges.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer

- B. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.8 WARRANTY

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions”

## PART 2 - PRODUCTS

### 2.1 PRESSURE GAUGES

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Ashcroft.
    - b. Wika.
    - c. Weskler.
    - d. Substitutions: Not Permitted.
- B. Type: Differential or Gauge - Bourdon tube actuated dial face pressure gauge.
- C. Dials:
  - 1. Nominal Diameter: 4-1/2 inches. Minimum 4 inches.
  - 2. Face: White, laminated plastic dials with black graduations.
  - 3. Scale: Extend over arc not less than 200 and not more than 270 degrees.
  - 4. Ranges and Graduation Units: As indicated on Instrument Schedule.
- D. Cases:
  - 1. Liquid filled.
  - 2. Material: Phenolic or Type 316 stainless steel.
  - 3. Provide removable rear plate.
  - 4. For gauge pressure, vented case for temperature/atmospheric compensation
  - 5. Windows:
    - a. Material: Clear acrylic or shatterproof glass.
    - b. Thickness: 1/8 inch.
    - c. Provide gasket.

E. Connection:

1. Location: Bottom.
2. Socket:
  - a. 1/2-inch NPT male thread.
  - b. Material: Brass forging.
  - c. Extend minimum 1-1/4 inches below gauge cases.
  - d. Provide wrench flats.
3. Mounting: Stem or surface.

F. Measuring Element:

1. Bourdon Tubes:
  - a. Material: Stainless steel, to brass socket.
  - b. Provide welded, stress-relieved joints.
2. Movement:
  - a. Material: Stainless steel.
3. Accuracy:
  - a. Comply with ASME B40.100.
  - b. Plus and minus 1.0 percent of full-scale range.

G. Adjustment:

1. Provide for zero-reading adjustment.
2. Adjusting Screws: Accessible from rear of case without need for disassembly.

H. Accessories:

1. Pressure Snubber:
  - a. Material: Type 316 stainless steel.
  - b. Provide isolation valve.
2. Shutoff Cocks: Furnished by gauge manufacturer.
3. Special scales: Engineer reserves the right to require special scales and/or calibration if the manufacturer's standard is not suitable for the application.
4. Gauges listed as liquid filled in the instrument device schedule shall be liquid filled at the factory.
5. For each differential pressure gauge, provide a three-valve manifold. The manifold shall be Type 316 stainless steel. Manifolds shall be D/A Manufacturing or Anderson Greenwood.

## 2.2 SOURCE QUALITY CONTROL

- A. Section 014000 “Quality Requirements” for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.

## PART 3 - EXECUTION

### 3.1 CONNECTIONS

- A. Refer to Section 260519 “Low Voltage Electrical Power Conductors and Cables.”

### 3.2 IDENTIFICATION

- A. Refer to drawings for tagging designations

### 3.3 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407313

## SECTION 407326 - GAUGE-PRESSURE TRANSMITTERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes gauge-pressure transmitters.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.8 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## PART 2 - PRODUCTS

### 2.1 GAUGE PRESSURE TRANSMITTERS

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Rosemount.
    - b. Endress Hauser.
    - c. Foxboro IGP20.
    - d. Substitutions: Not Permitted.
- B. Performance Requirements
  - 1. Capacities and Characteristics:
    - a. Microprocessor based, intelligent type.
    - b. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.
    - c. Accuracy: 0.075 percent of span.
    - d. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change.
    - e. Stability: 0.05 percent of upper range limit for 1 year.
    - f. Output Signal: 4 to 20 mA DC linear with pressure, with HART protocol.
    - g. Output: Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.
    - h. Operating Temperature Range: -20 to 80 degrees C.
    - i. Response Time: Less than 1 ms.
  - 2. Display:
    - a. Digital indicator displaying pressure in the engineering units indicated in the Instrument Device Schedule.

3. Diagnostics:
  - a. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
  - b. Simulation capability for inputs and loop outputs.
  - c. Test terminals available to ease connection for test equipment without opening the loop.
  - d. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
4. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.

C. Materials

1. Enclosure:
  - a. NEMA 4X (IP66), explosion proof.
  - b. Approved for Class I, Division 1, Groups C and D (EEx d IIC T5).
2. Process Wetted Parts, except for ozone/oxygen service:
  - a. Isolating diaphragm and other wetted metal parts of Type 316L stainless steel, unless otherwise indicated in the device schedule.
  - b. Gaskets and O rings shall be Teflon.

2.2 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 26 05 19 “Low Voltage Electrical Power Conductors and Cables.”

### 3.4 IDENTIFICATION

- A. Refer to drawings for tagging designations

### 3.5 FIELD QUALITY CONTROL

- A. Gauge-pressure transmitters will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 “Process Control and Enterprise Management General Provisions.”
  - 2. Section 406121 “Process Control System Testing.”

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system’s operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407326



## SECTION 407336 - PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes pressure and differential pressure switches.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.8 FIELD CONDITIONS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.9 WARRANTY

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

## PART 2 - PRODUCTS

### 2.1 PRESSURE SWITCHES

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Ashcroft.
    - b. Dwyer.
    - c. Kele J21K Series.
    - d. Substitutions: Not Permitted.
- B. Type:
  - 1. Pressure: two-valve manifold (with annular seal).
- C. Materials:
  - 1. Diaphragm: Stainless steel.
  - 2. Wetted parts: 316L Stainless steel.
  - 3. Seals: Viton.
  - 4. Connection port: 316 Stainless steel.
- D. Accuracy
  - 1. Pressure: Plus or minus 5 percent of operating range.
  - 2. Differential Pressure: Plus or minus 20 percent of full-scale range.

- E. Repeatability: Better than 1 percent of full scale.
- F. Dead Band: Adjustable to 60 percent of full scale.
- G. Set Points: Adjustable between 20 and 80 percent of adjustable range.
- H. Reset: Unit shall be of the automatic reset type unless noted otherwise in the Instrument Device Schedule.
- I. Over Range Protection: Over range protection to 150 percent of the maximum process line pressure.
- J. Hermetically-sealed switches.
- K. Connection:
  - 1. Location: Bottom.
  - 2. Size: 1/4 inch.
  - 3. Furnish taps for sensing lines.
- L. Electrical:
  - 1. Contacts:
    - a. One or Two as detailed on the Instrument Device Schedule.
    - b. SPDT.
    - c. Type: Snap action, according to NEMA ICS 1.
  - 2. Ampacity: 10 A at 230 V AC.
- M. Enclosures: NEMA 250 Type 4X.
- N. Differential Pressure Switches:
  - 1. Differential Range:
    - a. Adjustable.
    - b. Maximum: 0.50inch water at low end.
    - c. Minimum: 6inches water at high end.
  - 2. Maximum Operating Pressure: Up to 300 percent of rated pressure.
  - 3. Transmitter: Operable with low-pressure connection disconnected.
- O. Accessories:
  - 1. Valves:
    - a. Pressure: Provide a Type 316 stainless-steel shutoff valve. Valve shall be by D/A Manufacturing, Anderson Greenwood, or Equal.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.5 FIELD QUALITY CONTROL

- A. Pressure switches will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407336

## SECTION 407363 - DIAPHRAGM SEALS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes diaphragm seals.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

1.8 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

1.9 WARRANTY

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

PART 2 - PRODUCTS

2.1 DIAPHRAGM SEALS – ANNULAR FLANGE MOUNTED

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
  - a. Onyx Valve.
  - b. Wika.
  - c. Ashcroft 81 Series.
  - d. Substitutions: Not Permitted.

B. Type:

1. Line mounted, between two flanges.

C. Function/Performance:

1. Pressure Limit: Correspond to flange ratings.
2. Inside diameter shall conform to the dimensions of the pipe where the seal is installed.
3. ANSI or DIN flange class shall be equivalent to the flange class of the piping where the seal is installed. Bolting dimensions shall conform to ANSI or DIN drilling specifications as required by the installation.

D. Physical:

1. Body Material and Flange: Type 316 stainless steel and compatible with process connection.
2. Process Connection: 1/4-inch NPT.
3. Wetted Parts and Bolt Materials: Corrosion resistant to process fluid.
4. Sensing Liquid: Silicone Oil.

## 2.2 SOURCE QUALITY CONTROL

- A. Section 014000 “Quality Requirements”: Requirements for testing, inspection, and analysis.
- B. Diaphragm Seals:
  - 1. Factory-assemble, fill, and calibrate entire assembly, including gage and switch, prior to shipment.
  - 2. Field filling is not acceptable.
- C. Provide shop inspection and testing of completed assembly.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 “Low Voltage Electrical Power Conductors and Cables.”

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.5 FIELD QUALITY CONTROL

- A. Diaphragm seals will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407363



## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes resistance temperature devices.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."
  - 3. Section 407463 "Temperature Transmitters."

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

### 1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each RTD, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For RTDs.

### 1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 QUALITY ASSURANCE

- A. Provide components compatible with functions required to form complete working system.
- B. Ensure that materials of construction of wetted parts are compatible with process liquid.
- C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 016000 “Product Requirements” for delivery, storage, and handling requirements.

## 1.9 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 RESISTANCE TEMPERATURE DEVICES (RTD)

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Foxboro
    - b. Rosemount.
    - c. Siemens.
    - d. Smar
    - e. TE Connectivity
    - f. Substitutions: Not Permitted.
- B. Type:
  - 1. Thin-film RTD
- C. Function/Performance:
  - 1. Accuracy: Plus or minus 0.1 percent at 32 degrees F.

2. Base Resistance at 32 degrees F: 100 ohms.
3. Thermal Coefficient of Resistance:  $0.00391 \Omega/\Omega^{\circ}\text{C}$
4. Stability: Tested to meet IEC 60751.
5. Tolerance: Class B, according to IEC 60751.
6. Vibration Resistance: 3g over frequency range 5 Hz to 500 Hz. Tested to meet IEC 60751.
7. Self-Heating: Tested to meet IEC 60751.

D. Physical:

1. Material: Platinum
2. Comply with ASTM E1137/E1137M.
3. Encapsulation: Epoxy.
4. Configuration: Four-wire.
5. Connector: Four-pin; male.
6. Housing:
  - a. Welded housing
  - b. Material: Type 316L stainless steel.
  - c. Connection: Threaded.
7. Probe:
  - a. Length: suitable for installation location shown on Drawings.
  - b. Sheath Style: Stainless-steel
  - c. Operating Temperature: -58 to 482 degrees F
  - d. Maximum Response Time: 3.5 seconds.

E. Required Accessories:

1. Extension Cable: length as required by installation location shown on Drawings.
2. Molded Plastic Probe Connector:
3. Protective Head:
  - a. Material: Aluminum.

## 2.2 TRANSMITTER

A. Manufacturer:

1. Same manufacturer as RTD sensor, and in accordance with Section 407463 "Temperature Transmitters," as required by the instrument device schedule.

## 2.3 SOURCE QUALITY CONTROL

- A. Section 014000 "Quality Requirements" for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 260526 “Grounding and Bonding for Electrical Systems.”

### 3.4 IDENTIFICATION

- A. Refer to drawings for tagging designations

### 3.5 FIELD QUALITY CONTROL

- A. Resistance temperature devices will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 “Process Control and Enterprise Management General Provisions.”
  - 2. Section 406121.10 “Process Control System Testing (CDMS Performs Testing).”

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407413

## SECTION 407463 - TEMPERATURE TRANSMITTERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes temperature transmitters.
- B. Related Requirements:
  - 1. Section 406100 “Process Control and Enterprise Management Systems General Provisions.”
  - 2. Section 407000 “Instrumentation for Process Systems.”
  - 3. Section 407413 – “Resistance Temperature Devices”

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”
  - 2. Refer to Section 407000 “Instrumentation for Process Systems.”
- B. Shop Drawings:
  - 1. Refer to Section 407000 “Instrumentation for Process Systems.”

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions” for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each Temperature Transmitter for tests performed by a qualified testing agency.

- C. Evaluation Reports: For Temperature Transmitters.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.9 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## PART 2 - PRODUCTS

### 2.1 TEMPERATURE TRANSMITTER

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. ABB TTF300.
    - b. Foxboro RTT15S.
    - c. Rosemount 3144P.
    - d. Siemens SITRANS TF.
    - e. Smar TT301.
    - f. Substitutions: Not Permitted.
- B. Type:
  - 1. Remotely mounted, intelligent transmitter compatible with sensor provided.
- C. Function/Performance:

1. Digital Accuracy: Plus or minus 0.2 degrees C.
2. Stability: Plus or minus 0.1 percent or 0.1 degrees C, whichever is greater, for 24 months.
3. Operating Temperature: -40 to 85 degrees C.
4. Output: 4-20 mA DC signal, linear with temperature and communicates via HART protocol.
5. Output capable of being set as difference or average of two measured temperatures.
6. Output configurable with custom curves, including Callendar-Van Dusen correction.
7. Display: Digital indicator displaying temperature in engineering units.
8. Diagnostics:
  - a. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
  - b. LED indication of transmitter faults.
  - c. Capable of simulation of inputs and loop outputs.
  - d. Include test terminals to allow for connection of test equipment without opening the 4-20mA DC loop.

D. Physical:

1. Enclosure shall be NEMA 4X (IP66). Where indicated on Drawings to be installed in hazardous locations, the transmitter shall be explosion proof approved for Class I, Division 1, Groups C and D.
2. Power supply shall be 24 VDC loop power.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

### 3.3 CONNECTIONS

- A. Refer to Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to drawings for tagging designations.

### 3.5 FIELD QUALITY CONTROL

- A. Temperature transmitter will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 “Process Control and Enterprise Management General Provisions.”
  - 2. Section 406121.10 “Process Control System Testing (CDMS Performs Testing).”

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system’s operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407463



## SECTION 407469 - THERMOWELLS, PROTECTION TUBES, AND TEST THERMOWELLS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes thermowells.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."
  - 3. Section 4074XX "Sections for temperature measurement."

#### 1.3 DEFINITIONS

- A. Section 4074XX "Sections for temperature measurement": The XX in the number indicates all spec sections starting with the first 4 numbers (indicating a category described in the accompanying text) are included in the reference.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Provide components compatible with functions required to form complete working system.
- B. Ensure that materials of construction of wetted parts are compatible with process liquid.
- C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 016000 “Product Requirements” for delivery, storage, and handling requirements.

## 1.10 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 THERMOWELL

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Ashcroft.
    - b. Weksler.
    - c. Ametek/US Gauge.
    - d. Marshalltown Manufacturing Co.
    - e. O. Terice Co.
    - f. Palmer Wahl Instruments, Inc.
    - g. Moeller Instrument Co.
    - h. Substitutions: Not Permitted.

- B. Type:
  - 1. Lagged, threaded, and tapered.
  - 2. Insertion length to suit application.
  
- C. Function/Performance:
  - 1. Purpose: To separate the temperature measuring sensitive portion of a filled thermal system, thermocouple, or resistance temperature detector from potentially corrosive or damaging process media, and/or provide isolation for removal.
  - 2. Installation:
    - a. Pipe tap, threaded
    - b. Tank, flanged
  - 3. Hydrostatically pressure tested at 2500 PSI at 75 degrees F.
  
- D. Physical:
  - 1. Material: Stainless-steel Type 316L. Titanium for use with flanged thermowells.
  - 2. Tip Length: 3.5-inch minimum.
  - 3. Lagging Extension: 3-inch minimum.
  
- E. Required Accessories:
  - 1. Provide threadlets when required for thermowells installed directly onto the process pipe.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

### 3.2 FIELD QUALITY CONTROL

- A. Thermowells will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

### 3.3 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407469



## SECTION 407505 - MULTI-PARAMETER ANALYZER TRANSMITTER

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes gas detection controllers.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.9 FIELD CONDITIONS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## PART 2 - PRODUCTS

### 2.1 GAS DETECTION CONTROLLER

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Sensidyne.
    - b. MSA.
    - c. Hach.
    - d. Substitutions: Not Permitted.
- B. Type:
  - 1. Multi-channel controller for fixed gas detection transmitters with enough input capacity for all transmitters shown on drawings plus 10 percent spares.
    - a. PTB-CGD-CP: Minimum (25) 4-20mA inputs.
    - b. PGTB-CGD-CP: Minimum (10) 4-20mA inputs.
- C. Function/Performance:
  - 1. Accuracy:  $\pm 0.1$  percent of span.
  - 2. Repeatability:  $\pm 0.05$  percent of span.
  - 3. Response Time: 60 seconds to 90 percent of value on a step change.
  - 4. Temperature Compensation: Compensation over entire temperature range of the instrument.
  - 5. Environmental Conditions: -10 to 55 °C and 5 to 95 percent relative humidity.
  - 6. Hardwired Outputs:
    - a. Minimum: (6) 4-20mA outputs.

- b. Minimum: (24) 120VAC, 5A, configurable relays.
- 7. Network Communications:
  - a. Modbus/TCP.
- 8. Diagnostics: On screen instructions and display of self-diagnostics.
- D. Physical:
  - 1. Controller shall be wall mountable.
  - 2. Enclosure shall be NEMA 4X (IP65).
  - 3. Power Requirements: 120VAC powered.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

#### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

#### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

#### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Gas detection controller will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

#### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407505



## SECTION 407613 - OXYGEN GAS ANALYZERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes oxygen gas analyzers.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each oxygen gas analyzer, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For oxygen gas analyzers.

1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

1.10 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

PART 2 - PRODUCTS

2.1 AMBIENT OXYGEN DETECTOR

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Sensidyne SensAlert ASI Series.
    - b. Dräger PointGard II.
    - c. MSA Ultima Series.
    - d. Substitutions: Not Permitted.
- B. Sensor:
  - 1. Type:
    - a. Electrochemical type sensor.
  - 2. Function/Performance:

- a. Response Time: T50 in less than 30 seconds at 20 degrees C.
  - b. Temperature Range: -20 to 40 degrees C.
  - c. Sensor Life: 1 year minimum.
3. Physical:
- a. Suitable for remote wall or ceiling mounting, or directly fitted to transmitter as indicated on the Drawings.
  - b. In non-hazardous areas, remote sensor enclosures shall be NEMA 4X (IP65). Where indicated in the Instrument Device Schedule or on the Drawings to be installed in hazardous areas, enclosures shall be explosion proof, approved for Class 1, Division 1, Groups C and D areas.
  - c. Detectors that are mounted below 6 feet above floor level shall be fitted with splash guards supplied by the manufacturer, to protect the sensor from accidental wetting.
4. Accessories Required:
- a. Mounting brackets for mounting as indicated on Drawings.
- C. Remote Indicating Transmitter/Controller:
1. Type:
    - a. Electronic, microprocessor-based single channel transmitter compatible with sensor provided.
  2. Function/Performance:
    - a. Linearity:  $\pm 2$  percent of full scale.
    - b. Repeatability:  $\pm 1$  percent of full scale.
    - c. Range: 0 to 25 percent oxygen by volume.
    - d. Environmental Conditions: -20 to 50 °C and 0 to 95 percent relative humidity.
    - e. Output: One 4-20 mA output proportional to calibrated range. Minimum of two programmable relay contacts for alarm and/or one fault relay contact.
    - f. Display: Digital display indicating the gas level, alarm or fault messages, and diagnostic information.
  3. Physical:
    - a. NEMA 4X (IP65) enclosure. Where indicated in the Instrument Device Schedule or on the Drawings to be installed in hazardous areas, transmitters shall be approved for Class 1, Division 1, Groups C and D.
    - b. Suitable for surface mounting.
    - c. The sensor shall be mounted in accordance with manufacturer's recommendation.
  4. Accessories Required:
    - a. One year's supply of calibration and test gas for detectors indicated in the Instrument Device Schedule or on Drawings.
    - b. Calibrator, fittings, hoses, and other devices require for calibration of detectors.

D. Manufacturer Start-up and Training services:

1. Provide manufacturer's start-up and training services as specified in the start-up and training services paragraph.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Oxygen gas analyzers will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  1. Complete installation and startup checks according to manufacturer's written instructions.
  2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control

system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

### 3.7 MAINTENANCE SERVICE

- A. Vendor Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
- B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians and operators. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter

END OF SECTION 407613



## SECTION 407623 - COMBUSTIBLE GAS ANALYZERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes combustible gas analyzers.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each combustible gas analyzer, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For combustible gas analyzers.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.10 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## PART 2 - PRODUCTS

### 2.1 COMBUSTIBLE GAS/LEL DETECTOR

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Sensidyne SensAlert ASI Series.
    - b. Dräger Polytron 8310 IR Series.
    - c. MSA Ultima XIR Series.
    - d. Substitutions: Not Permitted.
- B. Sensor:
  - 1. Type:
    - a. Intrinsically safe.
    - b. Continuous infrared sensor.
  - 2. Function/Performance:



- a. Response Time: T90 in less than 30 seconds.
  - b. Temperature Range: -50 to 90 degrees C.
  - c. Sensor Life: 3 years typical.
3. Physical:
- a. Infrared sensor technology.
  - b. Suitable for remote wall or ceiling mounting, or directly fitted to transmitter as indicated on the Drawings.
  - c. The sensor shall be mounted approximately 1 - 3 feet below the ceiling in accordance with manufacturer's recommendation.
4. Accessories Required:
- a. Sufficient cable up to 50 feet of the type recommended by the manufacturer shall be provided for installation between sensor and transmitter as required by the installation indicated on the Drawings.
  - b. Remote sensor enclosures shall be explosion proof, approved for Class 1, Division 1, Groups C and D areas.
  - c. For convenient calibration, sensors that are inaccessible to an individual standing on the floor, shall be fitted with calibration cups with connected stainless-steel tubing running to a point adjacent to the transmitter. Tubing installation shall conform to tubing installation requirements specified elsewhere.
- C. Remote Indicating Transmitter/Controller:
1. Type:
    - a. Electronic, microprocessor based single channel transmitter compatible with sensor provided.
  2. Function/Performance:
    - a. Accuracy:  $\pm 3$  percent up to 50 percent LEL,  $\pm 5$  percent for greater than 50 percent LEL.
    - b. Range: 0 to 100 percent LEL.
    - c. Environmental Conditions: -20 to 60 degrees C; 10 to 95 percent relative humidity.
    - d. Output: One 4-20 mA output proportional to calibrated range. Two programmable relay contacts for warning, alarm, and/or fault.
    - e. Display: Digital display indicating the gas level, alarm or fault messages, and diagnostic information.
  3. Physical:
    - a. Explosion proof enclosure approved for Class 1, Division 1, Groups B, C, and D.
    - b. Suitable for surface mounting at elevation shown on Drawings.
  4. Accessories Required:

- a. Handheld programming unit if required for setup and calibration.

D. Manufacturer Start-up and Training services:

1. Provide manufacturer's start-up and training services as specified in the "Start-Up and Training Services" Paragraph.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Combustible gas analyzers will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  1. Complete installation and startup checks according to manufacturer's written instructions.
  2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the

instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

### 3.7 MAINTENANCE SERVICE

- A. Vendor Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
- B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians and operators. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.

END OF SECTION 407623



## SECTION 407633 - HYDROGEN SULFIDE ANALYZERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes hydrogen sulfide analyzers.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each hydrogen sulfide analyzer, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For hydrogen sulfide analyzer.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.10 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## PART 2 - PRODUCTS

### 2.1 HYDROGEN SULFIDE DETECTOR

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Sensidyne SensAlert ASI Series.
    - b. Dräger PointGard II.
    - c. MSA Ultima Series.
    - d. Substitutions: Not Permitted.
- B. Sensor:
  - 1. Type:
    - a. Integral hydrogen sulfide gas sensors shall be the continuous diffusion type, which change resistance when exposed to hydrogen sulfide.
  - 2. Functional/performance:

- a. Continuously measure, indicate, and transmit ppm concentration of hydrogen sulfide in air. The speed of response to a step change in gas concentration shall be less than 10 seconds to 90 percent of final reading.
3. Physical:
    - a. The sensor shall be compact and of rugged construction to minimize accidental damage of materials and to resist corrosive atmospheres and poisoning of the sensor.
    - b. It shall have positive flame arresting protection and be suitable for installation in atmospheres falling under NEC Class I, Division I, Group D classifications.
    - c. The sensor shall be integral with the transmitter and be of explosion proof construction.
    - d. The sensor shall be mounted to prevent moisture accumulation.
    - e. The sensor shall be mounted approximately -1.5 - 3 feet above the floor in accordance with manufacturer's recommendation.
  4. Expendables:
    - a. The sensor shall have a useful life of 2 years under normal operating conditions.
  5. Accessories Required:
    - a. Mounting brackets for mounting as indicated on the Drawings.
    - b. In non-hazardous areas, remote sensor enclosures shall be NEMA 4X (IP65). Where indicated in the Instrument Device Schedule or on the Drawings to be installed in hazardous areas, enclosures shall be explosion proof, approved for Class 1, Division 1, Groups C and D areas.
    - c. Detectors that are mounted below 6 feet above floor level shall be fitted with splash guards supplied by the manufacturer, to protect the sensor from accidental wetting.
- C. Remote Indicating Transmitter/Controller:
1. Type:
    - a. Electronic, microprocessor-based transmitter compatible with sensor provided.
    - b. Single or dual channel as indicated on the Drawings or in the Instrument Device Schedule.
  2. Function/Performance:
    - a. Linearity:  $\pm 2$  percent of full scale.
    - b. Repeatability:  $\pm 1$  percent of full scale.
    - c. Range: 0 to 100 ppm.
    - d. Environmental Conditions: -20 to 50 °C and 0 to 95 percent relative humidity.
    - e. Output: One 4-20 mA output proportional to calibrated range. Two relay contacts for alarm and one fault relay contact.
    - f. Digital display indicating the gas level, alarm or fault messages, and diagnostic information.

3. Physical:
    - a. NEMA 4X (IP65) enclosure approved for Class 1, Division 1, Groups C and D.
    - b. Suitable for surface mounting at elevation shown on drawings
    - c. A DC power supply shall be provided with each transmitter. The power supply shall be installed in an enclosure having the same certification as the enclosure for the transmitter.
  4. Accessories Required:
    - a. One-year supply of calibration and test gas for detectors indicated in the Instrument Device Schedule or on the Drawings.
    - b. Calibrator, fittings, hoses, and other devices require for calibration of detectors.
    - c. In lieu of the above, if the vendor offers a "Sensor Exchange" program as a standard offering, a year of this Sensor Exchange program is acceptable. This program shall deliver a freshly calibrated sensor at manufacturer recommended calibration intervals for replacement of the existing sensor. All information shall be uploaded to the transmitter for the new sensor with no further maintenance required for the new sensor to function properly.
- D. Manufacturer Start-up and Training Services:
1. Provide manufacturer's start-up and training services as specified in the start-up and training services paragraph.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Control and Enterprise Management Systems General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.



### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Hydrogen sulfide analyzers will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

### 3.7 MAINTENANCE SERVICE

- A. Vendor Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
- B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians and operators. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.

END OF SECTION 407633



## SECTION 407643 - CARBON MONOXIDE ANALYZERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes carbon monoxide analyzers.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 407000 "Instrumentation for Process Systems."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."
- B. Shop Drawings:
  - 1. Refer to Section 407000 "Instrumentation for Process Systems."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions" for any PCSS requirements regarding informational submittals for instruments.
- B. Product Test Reports: For each carbon monoxide analyzer, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For carbon monoxide analyzers.

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.10 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## PART 2 - PRODUCTS

### 2.1 CARBON MONOXIDE DETECTOR

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Sensidyne SensAlert ASI Series.
    - b. Dräger PointGard II.
    - c. MSA Z Gard Series.
    - d. Substitutions: Not Permitted.
- B. Sensor:
  - 1. Type:
    - a. Intrinsically safe.
    - b. Metal oxide sensing element.
  - 2. Function/Performance:

- a. Accuracy:  $\pm 5$  percent full scale at 50 percent relative humidity.
  - b. Temperature Range: 0 to 40 degrees C.
  - c. Humidity: 0 to 95 percent relative humidity.
3. Physical:
    - a. The sensor shall be mounted approximately 5 feet above the floor or in accordance with manufacturer's recommendation.
  4. Accessories Required:
    - a. For convenient calibration, sensors that are inaccessible to an individual standing on the floor, shall be fitted with calibration cups with connected stainless-steel tubing running to a point adjacent to the transmitter. Tubing installation shall conform to tubing installation requirements specified elsewhere.
    - b. Detectors that are mounted below 6 feet above floor level shall be fitted with splash guards supplied by the manufacturer, to protect the sensor from accidental wetting.
- C. Remote Indicating Transmitter/Controller:
1. Type:
    - a. Electronic, microprocessor based single channel transmitter compatible with sensor provided.
  2. Function/Performance:
    - a. Range: 0 to 100 ppm.
    - b. Environmental Conditions: 0 to 40 °C; 0 to 95 percent relative humidity.
    - c. Output: One 4-20 mA output proportional to calibrated range. Programmable relay contacts for warning, alarm, and/or fault.
    - d. Display: Digital display indicating the gas level, alarm or fault messages, and diagnostic information.
  3. Physical:
    - a. Compatible to the environment specified in Drawings.
    - b. Suitable for surface mounting at elevation shown on Drawings.
  4. Accessories Required:
    - a. Handheld programming unit if required for setup and calibration.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 “Low Voltage Electrical Power Conductors and Cables.”

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Carbon monoxide analyzers will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system’s operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

### 3.7 MAINTENANCE SERVICE

- A. Vendor Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective

components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
- B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians and operators. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.

END OF SECTION 407643





## SECTION 407813 - INDICATORS AND METERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes indicators and meters.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions" for submittal requirements.

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions" for preinstallation meetings

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."
- B. Shop Drawings:
  - 1. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions"

## 1.9 FIELD CONDITIONS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

## PART 2 - PRODUCTS

### 2.1 PANEL-MOUNTED DIGITAL INDICATORS

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Precision Digital.
    - b. Red Lion.
    - c. Dwyer.
    - d. Substitutions: Not Permitted.
- B. Type:
  - 1. Digital indicator.
- C. Function/Performance:
  - 1. Accuracy: Plus or minus 0.25 percent of calibrated range.
  - 2. Operating Temperature: -20 to 70 degrees C.
  - 3. Input: 4 to 20 mA.
  - 4. Output: retransmitted 4 to 20 mA.
  - 5. Digital Outputs: Two Form C programmable contacts rated for 5A at 120/240 VAC.
  - 6. Display: 5-digit LED display.
  - 7. Indicator Failure: Failure of the indicator will not cause failure of the 4-20 mA loop.
- D. Physical:
  - 1. Suitable for panel mounting.
  - 2. NEMA 4X and explosion-proof approved for Class I, Division 1, Groups C and D areas.
  - 3. Programmable via integrated keypad.

4. Power Requirements: 24VDC.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

#### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

#### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

#### 3.5 FIELD QUALITY CONTROL

- A. Indicators and meters will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  1. Section 406100 "Process Control and Enterprise Management General Provisions."
  2. Section 406121 "Process Control System Testing."

#### 3.6 STARTUP SERVICE

- A. Perform startup service.
  1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407813



## SECTION 407816 - INDICATING LIGHTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes indicating lights.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.4 INFORMATIONAL SUBMITTALS

- 1. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.5 CLOSEOUT SUBMITTALS

- 1. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

1.8 FIELD CONDITIONS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

PART 2 - PRODUCTS

2.1 PILOT TYPE INDICATING LIGHTS

- A. Manufacturers:
1. Manufacturers and their products are subject to compliance with requirementsProvide one of the following:
    - a. Square D.
    - b. Cutler-Hammer.
    - c. Allen Bradley.
    - d. Substitutions: Not Permitted.
- B. Type: Energy efficient Solid-State LED Lamps.
- C. Functional:
1. Units shall be provided with low voltage LED lamps suitable for the voltage supplied.
  2. Lights supplied with 120V AC power shall have integral reduced voltage transformers.
  3. Lamps shall be replaceable from the front of the unit.
- D. Physical:
1. Lens color:
    - a. Running, on, open - Red.
    - b. Stopped, off, closed - Green.
    - c. Alarm - Amber.
    - d. White - Power on.
    - e. Blue - All other status indications not covered by the above.
    - f. Lens caps shall be approximately .46 inch diameter. Provide legend faceplates engraved to indicate the required function of each device; NEMA rating - 4X.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.2 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.3 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.4 FIELD QUALITY CONTROL

- A. Indicating lights will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.5 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407816





## SECTION 407819 - SWITCHES AND PUSH BUTTONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes switches and push buttons.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

## 1.8 FIELD CONDITIONS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

## PART 2 - PRODUCTS

### 2.1 SELECTOR SWITCHES AND PUSHBUTTONS

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Allen Bradley.
    - b. Crouse Hinds (NEMA 7).
    - c. Cutler-Hammer.
    - d. General Electric.
    - e. Square D.
    - f. Substitutions: Not Permitted.
- B. Type:
  - 1. Control devices shall be heavy-duty oil tight type with stackable contact blocks.
- C. Functional:
  - 1. Provide contact arrangement and switching action as required for the control system specified.
- D. Physical:
  - 1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide silver sliding contacts rated 5 amps at 125 VDC, for electronic (millivolt/milliamp) switching provide contacts rated 1 amp at 28 VDC.
  - 2. Pushbuttons shall have flush type operators.
  - 3. Selector switches shall have knob or wing lever operators; NEMA rating - 4X; Provide legend plates denoting switch/pushbutton position/ function.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.5 FIELD QUALITY CONTROL

- A. Switches and push buttons will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407819



## SECTION 407853 - RELAYS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes relays.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions" for submittal requirements.
  - 2. Section 406733 "Panel Wiring."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions" for preinstallation meetings

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."
- B. Shop Drawings:
  - 1. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

## 1.6 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 GENERAL PURPOSE RELAYS AND TIME DELAYS

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
  - a. Square D.
  - b. Cuttler-Hammer.
  - c. Allen Bradley.
  - d. Substitutions: Not Permitted.

B. Type:

1. General purpose plug-in type.

C. Functional:

1. Contact arrangement/function shall be as required to meet the specified control function; Mechanical life expectancy shall be in excess of 10 million operations.
2. Duty cycle shall be rated for continuous operation; Units shall be provided with integral indicating light to indicate if relay is energized.
3. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
4. Time delay units shall be adjustable and available in ranges from 0.1 second to 4.5 hours.

D. Physical:

1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide contacts rated 5 amps at 28 VDC, for electronic (milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service; relays shall be provided with dust and moisture resistant covers.
2. All relays shall be provided with number of poles required to meet the design intent.

E. Options/Accessories Required:

1. Provide blade terminal din rail mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
2. Provide mounting rails/holders as required.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.2 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.3 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.4 FIELD QUALITY CONTROL

- A. Relays will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.5 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407853





## SECTION 407856 - ISOLATORS, INTRINSICALLY SAFE BARRIERS, AND SURGE SUPPRESSORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes isolators, inherently safe barriers, and surge suppressors.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 406733 "Panel Wiring."

#### 1.3 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions" for preinstallation meetings.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."
- B. Shop Drawings:
  - 1. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

## 1.6 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.9 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 SIGNAL ISOLATORS/BOOSTERS/CONVERTERS

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Pepperl & Fuchs.
    - b. Phoenix Contact.
    - c. Acromag.
    - d. Substitutions: Not Permitted.
- B. Type:
  - 1. Solid state, ASIC technology; electronic type.
- C. Functional:
  - 1. Accuracy: 0.15 percent.
  - 2. Inputs: Current, voltage, frequency, temperature, or resistance as required.
  - 3. Outputs: Current or voltage as required.
  - 4. Isolation: There shall be complete isolation between input circuitry, output circuitry, and the power supply.
  - 5. Adjustments: Zero and span adjustment shall be provided.
  - 6. Protection: Provide RFI protection.

D. Physical:

1. Mounting: DIN Rail.

## 2.2 INTRINSIC SAFETY BARRIERS

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
  - a. Pepperl & Fuchs.
  - b. MTL.
  - c. R. Stahl.
  - d. Substitutions: Not Permitted.

B. Type:

1. Barriers shall be of the solid-state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe usage in hazardous areas.
2. Provide a barrier for instrumentation and equipment transmitting analog or digital signals that originate in a hazardous area as indicated in the design documents.

C. Options Required:

1. Barriers shall match power supply provided.
2. Barriers shall be located in non-hazardous areas.

## 2.3 INTRINSIC SAFETY BARRIERS (FOR 2-WIRE TRANSMITTER SYSTEMS)

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
  - a. Pepperl & Fuchs.
  - b. MTL.
  - c. R. Stahl.
  - d. Substitutions: Not Permitted.

B. Intrinsic safety barriers shall be passive devices requiring no external voltage supply and supplied with series resistors, series fuse and shunt zener diodes to limit the transfer of energy to levels required by intrinsically safe protection between safe and hazardous locations.

C. Unit shall be Factory Mutual approved and certified for use in accordance with National Fire Protection Association (NFPA 493).

## 2.4 SURGE PROTECTION FOR CONTROL SYSTEMS

- A. **Manufacturers:**
1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Phoenix Contact.
    - b. MTL.
    - c. Citel DLA Series.
    - d. Substitutions: Not Permitted.
- B. Provide protection of all analog signal (4-20 mA) circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Protection devices located near the transmitter shall be mounted in a separate NEMA 4X enclosure or conduit mounted. Substitution of a single device to protect both 120 VAC and 4-20 mA wires to an instrument is acceptable.
- C. Provide protection of all 120 VAC power feeds into control panels, instruments, and control room equipment.
- D. **Non-Fiber Based Data Highway or Communications Circuits:** Provide protection on all communication and data highway circuits that leave a building or are routed external to a building. Provide circuit protection at both ends of the line.
1. **Products:** Provide one of the following surge protective devices:
    - a. Phoenix Contact.
    - b. MTL.
    - c. Citel DLA series.
- E. **RF Coaxial Cable:** Provide protection on communication cables between radios and antennas, mounted either inside the panel, or in the wall of the enclosure in accordance with NEMA and UL 497E standards. Surge protection devices shall be Citel P8AX series, Polyphaser, or equal.
- F. **Inductive Loads:** Provide coil surge suppression devices, such as varistors or interposing relays, on all process controller outputs or switches rated 120 VA or less that drive solenoid, coil, or motor loads.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. **Wiring within Enclosures:** Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

### 3.2 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

### 3.3 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

### 3.4 FIELD QUALITY CONTROL

- A. Isolators, inherently safe barriers and surge suppressors will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121 "Process Control System Testing."

### 3.5 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407856



## SECTION 407859 - POWER SUPPLIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes power supplies.
- B. Related Requirements:
  - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions."
  - 2. Section 406733 "Panel Wiring."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

#### 1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 "Process Control and Enterprise Management System General Provisions."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 "Process Control and Enterprise Management Systems General Provisions."

## 1.7 FIELD CONDITIONS

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## 1.8 WARRANTY

- A. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

## PART 2 - PRODUCTS

### 2.1 24 VDC POWER SUPPLIES

- A. Manufacturers:
  - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
    - a. Allen-Bradley.
    - b. SOLA.
    - c. Phoenix Contact.
    - d. Substitutions: Not Permitted.
- B. Provide a 24 VDC power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.
- C. Provide redundant power supplies that operate in parallel with an independent redundancy module to power field instruments and panel devices as shown on the drawings.
- D. The 24 VDC power supply shall meet the following requirements:
  - 1. Input Power: 115 VAC, plus or minus 10 percent, 60 Hz.
  - 2. Output Voltage: 24 VDC.
  - 3. Output Voltage Adjustment: 5 percent.
  - 4. Line Regulation: 0.05 percent for 10 volt line change.
  - 5. Load Regulation: 0.15 percent no load to full load.
  - 6. Ripple: 3 mV RMS.
  - 7. Operating Temperature: 32 to 140 degrees Fahrenheit.
- E. Size the 24 VDC power supply to accommodate the design load plus a minimum 25 percent spare capacity.
- F. If power supply on/off status signal is shown on drawings, provide a relay contact (internal to the power supply or external if the power supply is not so equipped) to indicate on/off status of the power supply.



- G. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.
- H. Mount the 24 VDC power supply such that dissipated heat does not adversely affect other panel components.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Refer to Section 406100 "Process Control and Enterprise Management General Provisions."

#### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

#### 3.3 CONNECTIONS

- A. Refer to Section 260519 "Low Voltage Electrical Power Conductors and Cables."

#### 3.4 IDENTIFICATION

- A. Refer to Drawings for tagging designations.

#### 3.5 FIELD QUALITY CONTROL

- A. Power supplies will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports in accordance with the following:
  - 1. Section 406100 "Process Control and Enterprise Management General Provisions."
  - 2. Section 406121.10 "Process Control System Testing."

#### 3.6 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 407859



## SECTION 411213.36 - SCREW BULK MATERIAL CONVEYORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes: Shaftless screw-type conveyors for conveying wet screenings to washer/compactors or loading into haul boxes via screenings/grit chute.
- B. Related Requirements:
  - 1. Section 055000 "Metal Fabrications" for miscellaneous metalwork and fasteners as required by this Section.
  - 2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections to equipment specified in this Section.
  - 3. Section 400557.00 "Actuators for Process Valves and Gates"
  - 4. Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment" for electric motors for conveyor drive units.
  - 5. Section 406100 "Process Control and Enterprise Management Systems."
  - 6. Section 406121 "Process Control System Testing."
  - 7. Section 406196 "Process Control Descriptions."
  - 8. Section 406733 "Panel Wiring."
  - 9. Section 407816 "Indicating Lights."
  - 10. Section 407819 "Switches and Pushbuttons."
  - 11. Section 407853 "Relays"

#### 1.3 PREINSTALLATION MEETINGS

- A. Convene minimum two weeks prior to commencing Work of this Section.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's product information for conveyor and component equipment.
- B. Shop Drawings:
  - 1. Dimensional drawings and details.
    - a. Drawings and details for the chute shall be stamped by a Professional Engineer licensed in the Commonwealth of VA.

2. Schedule of conveyor, knife gate and chute components.
3. Materials of construction.
4. Complete, dimensionally correct control panel drawings showing all components with complete wiring diagrams showing all signals. Equipment instrumentation and control description
5. Submit a memory map to the OWNER no later than 30 days prior to the scheduled shipment of the vendor equipment to the site.
6. Installation and anchoring requirements, including fasteners and other details.
7. Mounting details, and location and elevation of electrical controls.
  - a. Percentage of active trough area fill under design capacity for the screw.
  - b. The total weight of the equipment (including the weight of the single largest item or component).
  - c. Bill of materials for all equipment.
  - d. List of the manufacturer's recommended spare parts. Include gaskets, packing, etc, on the list.
  - e. Recommended summer and winter grade of lubricants along with alternative references to equal products of other manufacturers.
  - f. Documentation of the AGMA rating of the drive assembly.
  - g. Details of the torque overload device.
8. All information required by Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment".
9. Equipment Operations and Maintenance Manual as required by Section 017823 "Operation and Maintenance Data."

## 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Products meet or exceed the specified requirements:
  1. The auger is protected from overload when the auger's torsional loading exceeds 50 percent of its torsional rating.
  2. At its torsional rating, the stress in auger does not exceed 50 percent of the Fy value in the outermost extreme fiber of the flight material.
  3. Design calculations to verify conveyor components meet design requirements and CEMA requirements.
- B. Welder Certificates: Welders and welding procedures employed on the Work, verifying AWS qualification within previous 12 months.
- C. Manufacturer Instructions: Detailed instructions on installation requirements, including storage and handling procedures.
- D. Source Quality-Control Submittals: Results of shop/factory tests and inspections.
- E. Field Quality-Control Submittals: Results of Contractor-furnished tests and inspections.
- F. Manufacturer Reports: Equipment has been installed according to manufacturer instructions.
- G. Qualifications Statements: For manufacturer, installer, and welder.

- H. In the event it is not possible to conform to certain details of this Section, describe completely all non-conforming aspects.

## 1.6 QUALITY ASSURANCE

- A. Welding: Comply with AWS D14.1/D14.1M.
- B. Perform Work according to standards set by authorities having jurisdiction.
- C. Maintain a copy of each standard affecting Work of this Section on Site.
- D. Qualifications
  - 1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
    - a. Equipment manufacturers to have experience in the design and manufacture of equipment of similar size and capacity and present proof of successful operations involving each piece of equipment furnished.
  - 2. Installer: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.
  - 3. Welders: AWS qualified within previous 12 months for employed weld types.
- E. Services of the Manufacturer's Representative
  - 1. The equipment manufacturer shall furnish the services of a competent and experienced factory representative who has complete knowledge of proper installation, operation and maintenance of the equipment to inspect the installed equipment, provide vendor training to plant personnel in operation and maintenance of the equipment, perform an initial test run and conduct final performance testing.
    - a. One 8-hour day per shaftless screw conveyor (excluding travel time) for checking and inspecting the equipment after it is installed.
    - b. Four 4-hour training sessions delivered on different dates, per coordination with the Owner. Each training sessions shall be 2-hours classroom and 2-hours field. This instruction period shall be scheduled at least ten days in advance with the OWNER and shall take place prior to plant start-up and acceptance by the OWNER. The final approved copies of operation and maintenance manuals must have been delivered to the ENGINEER prior to scheduling the instruction period with the OWNER.
    - c. Minimum one 8-hour days per shaftless screw conveyor (excluding travel time) to conduct functional testing of the system dry.
    - d. Minimum one 8-hour days per shaftless screw conveyor to perform the initial test run on screenings and conduct final performance testing.
  - 2. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or CONTRACTOR's installation, additional service shall be provided at no change in Contract Price or Time.
  - 3. Manufacturer representative to be on-site for coordination and programming support with Owner Staff. Provide three 8-hour days on-site.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection: Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 1. Provide additional protection according to manufacturer instructions.

## 1.8 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

## 1.9 WARRANTY

- A. Furnish three-year manufacturer's warranty for screw conveyors, knife gates, chutes and appurtenances.

## PART 2 - PRODUCTS

### 2.1 SHAFTLESS SCREW CONVEYOR

- A. General: The Preliminary Treatment Building Screen Room is a Class I, Division 2, hazardous location per NFPA 820. All electrical equipment, conduit, wiring, installation, etc., within the classified area shall be suitable for Class I, Division 2 locations.
- B. Description: Provide two (2) horizontal shaftless screw conveyors with footprints as indicated on the drawings. Each shaftless screw conveyor shall be able to receive screenings from three (3) ½" bar screens. Each shaftless screw conveyor shall be able to convey screenings to two (2) washer/compactor units and two (2) screenings and grit collection bins via discharge chutes.
- C. Manufacturers:
  - 1. Spirac.
  - 2. Custom Conveyor Company.
  - 3. Or Engineer Approved Equal.
  - 4. Furnish materials according to standards set by authorities having jurisdiction.
- D. Performance and Design Criteria:
  - 1. Design Capacity: 250 cubic foot/hour.
  - 2. Service Duty: Continuous .
  - 3. Location: Indoor.
  - 4. Media:

- a. Raw uncompacted screenings from ½-inch bar screens
  - b. Characteristic: Screenings will include, but not limited to: fats, oils, and grease (FOG), scum, grit, long fibers, and any other inert or organic materials that may enter the plant from a combined collection system servicing a major metropolitan area.
  - c. Temperature: Ambient.
- E. Shaftless Spiral Assemblies: Manufactured from 2 concentric flights formed from high strength carbon or alloy steel and welded together to form a single spiral.
1. Spiral Flighting:
    - a. Cold-formed spring steel of minimum hardness 225 Brinell.
    - b. Maximum allowable stress in the extreme fibers not to exceed 0.5 Fy, 0.2 percent offset, under torsional loading at the brake horsepower requirement.
    - c. Full penetration welds at all splice connections.
    - d. Assure true alignment when assembled and according to manufacturer's recommendations.
    - e. Connect to drive system through a flanged connection plate.
      - 1) Connection plate is to be welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral.
    - f. Mating flange bolted to the spiral connection plate.
    - g. Provide a gland packing ring consisting of Teflon-coated packing rings to seal the drive shaft at its penetration through the end plate.
    - h. Flanged connection: Weld spiral flights with gusset plates for additional reinforcing.
    - i. Bushings between the pipe sleeve and the end shaft if necessary. Neither end nor intermediate bearings will be allowed.
    - j. A compression packing gland around the shaft at its penetrations through the trough end plates.
    - k. Snap rings to make the bearings and seals capable of supporting maximum thrust loads and preventing angular misalignment of the shaft.
  2. Spiral Diameter: 12 inches Minimum Outer Spiral Thickness: 2 ¼-inch x 1-inch.
  3. Spiral Pitch: 12-13 inches.
  4. Maximum Spiral Speed: 18 rpm.
  5. Form flight in a spiral-forming machine to diameter and pitch specified within a tolerance of plus or minus 0.080 inch from the theoretical for both pitch and diameter.
  6. The diameter of the shaftless spiral assembly to be constant over the entire length of the spiral.
- F. Conveyor Troughs:
1. Inlets: Sized to convey the load as specified and flanged allowing for connection to discharge assembly.
  2. Totally enclose conveyor to prevent release of odors.
  3. Coordinate inlet connections from the bar screens, including chutes and enclosure doors, with equipment manufacturer so the bar screens and shaftless screw conveyors fit together without interference or gaps.

4. Coordinate outlet connections to the washer/compactor units, including chutes and enclosure doors, with equipment manufacturer so the washer/compactor units and shaftless screw conveyors fit together without interference or gaps.
5. U-troughs of 10 gauge Type 304 stainless steel with removable 11 gauge.
6. Hardware: Type 316 stainless steel.
7. Maximum Section Lengths: Not to exceed 20 feet.
8. Butt Welded Flanges: With bolt holes for mounting end plates or other sections.
9. Cover Plates: Provided along conveyor lengths not receiving screenings.
  - a. Single-pieced formed sheet metal, not greater than five feet in length, attached to trough using toggle clamps that do not require any tools to place or remove.
  - b. When disconnected, clamps will not allow any of their parts to become detached from the conveyor trough.
    - 1) Trough covers: With turned-down edges parallel to the sides of the screw conveyor trough flange and turned up at 90 degrees for receiving a clamping bar at cover joints.
    - 2) Clamps: Less than 32-inch centers along length of the screw conveyor trough.
    - 3) Cover Section to have 2 handles for ease of removal.
      - a) Made from 3/8 inch diameter Type 304 stainless steel and formed into a "U".
      - b) Fully weld handles to covers via a pre-drilled backing plate that is welded to the cover as reinforcing.
    - 4) Neoprene Gasket: A minimum 3/32 inch of 50 durometer with appropriate adhesive for mating surfaces of the trough covers.
10. Hold Down Provisions: hold-down guide liners shall be mounted in the trough side above the design load fill level so that they do not interfere with the flow of conveyed product.
11. Provide 2-inch flanged drain connections as shown on the drawings.

G. Liner Material

1. Screw conveyor liner material to be an industrial ultra-high molecular weight (UHMW) material minimum 1/2 inch thickness that extends the full length of the trough, covering the entire semicircular bottom portion of the trough.
2. Liner material, meet or exceed:
  - a. Yield Strength at 75 degrees F: 5,000 psi.
  - b. Ultimate Tensile Strength at 75 degrees F: 8,500 psi.
  - c. Break elongation at 75 degrees F: 250 percent.
  - d. Dynamic Coefficient of Friction:
    - 1) Running Dry Against Polished Steel: 0.10.
    - 2) Work Hardened: 0.08.
  - e. Resistant against acids, grease and chemicals, no water penetration.
3. Liner material: ultra-high molecular weight (UHMW) polyethylene Duraslide Xylethon manufactured by Durawear Corp. or equal.



4. Liner to be installed as parallel strips, and secured at intervals not to exceed 10 feet, using Type 304 stainless steel retaining clips of an approved design.
5. Liner shall have two colors such that as the liner wears a different color is revealed when the liner will need to be replaced.

#### H. Conveyor Supports

1. Conveyor Framework: AISI 304 and 304L stainless steel
  - a. Design in conformance with the requirements of the latest revision of the AISC Standards for the Design, Fabrication and Erection of Structural Steel for Buildings.
  - b. Support loads: Base on a completely filled trough with screenings plus dead weight of the equipment.
  - c. Shop connections: Welded, riveted, or bolted.
  - d. Conveyor to be independently supported. Conveyor to be installed and disassembled without disturbing existing equipment.
2. Supporting Framework: Constructed of AISI Type 304 and 304L stainless steel using welded construction with bolted connections to conveyor casings, feet and support points.
  - a. Self-supporting, designed to a minimum of twice the natural frequency of the screw conveyor unit under all loading conditions.
  - b. Ratio of unbraced length to the least radius of gyration (slenderness ratio) not to exceed 120 for any compression member and not to exceed 240 for any tension member (of angles about the Z-Z axis).
  - c. Structural Members and Connections: Designed so unit stresses will not exceed AISC allowable stresses by more than 1/3 when subject to loading of twice the running torque of the drive motor.
  - d. Supports provided near the drive unit, approximately 1 to 2 feet, at a quantity of not less than one for every 12 feet or part thereof, of length of trough segment.
  - e. Support adjacent to the transfer.
  - f. Separate support consisting of same size and thickness of materials, integrally welded to trough at drive end to support the screw conveyor drive weight.
  - g. Coordinate supports with the screen and washer-compactor manufacturers to avoid conflicts for maintenance access.
3. Field connections to be bolted using reamed, subpunched holes and finished bolts as follows:
  - a. Attach Supporting Members to Concrete Filled Composite Steel Deck: Minimum 1/2 inch diameter Type 316 stainless steel adhesive anchors per Section 050519, "Post-Installed Anchors". A minimum of 2 bolts per supporting member.

#### I. Drive:

1. Each spiral conveyor shall be driven by a constant-speed gear reducer motor drive unit mounted to a bellhousing adapter flange mounted to the end plate of the conveyor. The adapter flange shall allow the leakage of any material from the conveyor trough to atmosphere rather than into the gear reducer/ motor drive unit. Direct coupling of the gear reducer/motor drive unit to the end flange of the conveyor will not be acceptable.

The drive unit shall be rigidly supported so there is no visible "wobble" movement under any operating condition. In the event of a prolonged power failure or emergency system shutdown the drive system shall be designed, at a minimum, to start the conveyor from a dead stop with the trough filled at 1.5 X the design load.

2. All gears shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have an AFBMA B-10 life of 30,000 hours. The reducer will be air-cooled unit with no auxiliary cooling requirement. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.
3. Type: Direct-coupled, helical gear.
4. Mounting: Shaft.
5. Bearings: Bronze sleeve.
6. Gear Reducers: Per AGMA 6013
  - a. Housing: Fully enclosed and oil tight.
  - b. Open Gearing: Enclosed with safety guard and removable covers for inspection and maintenance.

J. Controls:

1. Description:
  - a. The conveyors can be started and stopped manually from the local control panel or from PCS. The conveyors can run east or west to feed screenings to either washer compactor, but the primary direction of operation is "forward".
  - b. The conveyors can be set to run in automatic mode from PCS. The conveyor will run continuously if any of the screens are running and will stop three minutes after all the screens have stopped. If no diverter gate is directed towards the active conveyor, the conveyor will not run.
  - c. In the event of a motor overload, the conveyor motor starter can be reset from the MCC.
  - d. Refer to Control Logic per Section 406196 "Process Control Descriptions" for coordination with plant control system.
2. Refer to the P&IDs for requirements for control panel layout requirements (i.e., lights, switches, indicators) and I/O signals to plant control system.
3. Electrical Characteristics:
  - a. As specified in Section 260519 "Low Voltage Electrical Power Conductors and Cables".
  - b. Rating: 10 hp.
  - c. Voltage: 460 V, three phase, 60 Hz.
4. Motors: As specified in Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment."
5. Each drive shall automatically restart after a power failure.
6. Provide and install one Emergency Pull Cord device for the Screw Conveyors around perimeter of conveyors. When pulled, both Screw Conveyors shall stop and the 'Emergency pull cord switch actuation' signal shall activate.

7. Provide one Zero Speed switch for each Screw Conveyor. When tripped, the Screw Conveyor shall stop and the 'zero speed' signal shall activate.
8. Provide one High Torque switch for each Screw Conveyor. When tripped, the 'high torque' signal shall activate.
9. Provide one High Motor Winding Temperature Switch for each Screw Conveyor. When tripped, the Screw Conveyor shall stop and the 'overload' signal shall activate.

K. Finishes: As specified in Section 099100 "Painting."

## 2.2 CHUTES

A. Equip conveyors with filling and discharge chutes for transferring material to or from another piece of equipment. Three chutes will be provided on each shaftless screw conveyor, as shown on the drawings, to capture wet screenings from the ½" bar screens. Four chutes will be provided on each shaftless screw conveyor, as shown on the drawings, to discharge wet screenings to two washer/compactor units and two screening and grit collection bins.

1. Material: 10 gauge Type 304 stainless steel.
2. Welded construction inside and out.
3. Chute Flanges: Coordinate bolt holes for mounting to equipment.
4. External Stiffening Ribs: As required to limit stresses and deformation.
5. Chutes will include hinged access hatches with Typ 316 SS hinges and handles in the locations shown on the drawings.
6. Chutes will include fabric reinforced neoprene pant legs as shown on the drawings.
7. The screw conveyor manufacturer will be required to coordinate with the screen manufacturer described in Specification section 462114 to ensure the diverter gates provided in section 462114 can be properly connected to the screw conveyors as shown on the drawings.
8. The screw conveyor manufacturer will be required to coordinate with the washer/compactor manufacturer described in Specification section 462173.13 to ensure that the screw conveyor and washer/compactor units are properly connected, as shown on the drawings.

B. Furnish two Type 316 stainless steel chutes to receive wet screenings from the screw conveyors, compacted screenings from the washer/compactors, and grit from the grit washer classifiers as shown on the drawings. The chutes shall convey screenings and grit from the Preliminary Treatment Building Second Floor to the Screen and Grit Collection Bins on the First Floor via Debris Chute attachments (section 149182). Chutes shall be 3' by 3' at the Second Floor where receiving screenings and grit and taper down to 2' by 2' where penetrating through the Second Floor to the First Floor as shown on the drawings. Chutes shall extend 4'-6" below the Second Floor finished floor. Chutes shall be supported off of curb around openings on the Second Floor and furnished with attachment brackets for the debris chutes. Chute shall be designed to handle screenings and grit as described in this section, with a minimum thickness of 1/8". Chute anchors and brackets shall also be designed as described in this section.

1. Provide latched removable Type 316 stainless steel chute cover with 10" opening for fabric grit chute opening.

C. Two Fabric Grit Chutes shall be provided on the existing Grit Classifier discharge piping as shown on the drawings. Chutes shall be round vinyl fabric reinforced ripstop with flanged connection for attachment to existing grit clarifier discharge. Inside diameter to match existing

10-inch ductile iron pipe. Each chute shall be approximately 3-ft long such that the plain end of the chute terminates at the same elevation as the invert of the screw conveyor. Contractor to confirm dimensions and submit for approval.

## 2.3 KNIFE GATES

- A. Provide four electrically actuated knife gates as shown on the drawings intended to isolate each shaftless screw conveyors from each washer/compactor units. Knife gates shall be constructed of Type 304 SS and shall be water-tight. Manufacturer to provide remote local control station for actuators. Contractor to provide local control station enclosures. Actuators and knife gates shall comply with the details described in Specification Section 400551 "Process Valves."

## 2.4 ACCESS LADDER

- A. Provide two rolling ladders, grip step, 3-step, with 24-inch wide serrated metal steps. Ladder to be at 59-degree incline with 4-inch diameter casters and a minimum 450lb capacity. Ladder to be provided by U-line, model H-4364-10 or equal

## 2.5 FINISHES

- A. Shop Priming and Finishing of Ferrous or Steel Components: Per Section 099100 "Painting"

## 2.6 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of completed assembly.
- B. Owner Inspection: Make completed conveyor assembly available for inspection at manufacturer's factory prior to packaging for shipment.
  - 1. Notify Owner at least twenty-one days before inspection is allowed.
- C. Owner Witnessing: Allow witnessing of factory inspections and tests at manufacturer's test facility.
  - 1. Notify Owner at least twenty-one days before inspections and tests are scheduled.
- D. Certificate of Compliance: If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
  - 1. Specified shop tests are not required for Work performed by approved manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

### 3.2 INSTALLATION

- A. Install Work according to standards set by authorities having jurisdiction and as indicated on the approved shop drawings.
- B. Touchup Painting and Coating: As specified in Section 099100 "Painting."

### 3.3 FIELD QUALITY CONTROL

- A. Inspection:
  - 1. Operate screw conveyor for four to eight hours and during this time inspect for:
    - a. Loud or unusual noise.
    - b. Excess vibration.
    - c. Overheated drive assembly.
  - B. Prior to Start-up: Installation certificate from manufacturer's representative that equipment has been properly installed and is ready for start-up and functional testing.
  - C. Functional Testing: Startup conveyors with appurtenances without the addition of sludge.
    - 1. Perform a dry test run of the shaftless screw conveyors upon final installation to demonstrate the correct alignment, smooth operation, all instruments are communicating correctly with SCADA, freedom from vibration, absence of excessive noise and overheating of the parts and bearings. Each shaftless screw conveyor shall operate for four hours continuously during the dry test.
    - 2. An overload torque test shall be conducted to test the torque overload device to operate and stop the screw conveyor at a loading condition equal to 150 percent of the actual working load to protect the drive unit. Test procedures shall be as recommended by the manufacturer and shall be submitted for review.
    - 3. The necessary adjustments and settings to the torque overload device shall be made by the factory representative to ensure that the mechanical screen will stop, switch off the drive motor and sound an alarm when a predetermined overload condition occurs on the shaftless screw conveyors.
    - 4. All defects recorded during the above field tests shall be corrected by the supplier.
    - 5. In the event the mechanism fails to meet the above test, the necessary changes shall be made and the mechanism retested. If the mechanism remains unable to meet the test requirements to the satisfaction of the Owner, it shall be removed and replaced with a satisfactory mechanism at no additional cost to the Owner.
  - D. Performance Testing: Upon satisfactory completion of the functional testing.
    - 1. Test conveyors with screenings from all available screens for four hours continuously to establish operation, performance and system reliability without alarms.
    - 2. Adjust, repair, or modify, as needed to ensure proper operation and performance.
    - 3. Shutdowns to replace components failing to perform as specified will require the acceptance test to be repeated.
    - 4. Make final adjustments to equipment under direction of manufacturer's representative.
  - E. Acceptance Testing: Upon satisfactory completion of the performance testing.

1. Acceptance period shall be fourteen days of continuous operation per shaftless screw conveyor upon completion of performance testing. Manufacturer shall be available on-call and on-site within 24-hour notice, as needed during acceptance period.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative that is an employee of the manufacturer to train Owner's maintenance personnel to adjust, operate, and maintain units. Local sales representatives will not be an acceptable substitute for a manufacturer's service representative. Provide four four-hour sessions on different dates, per coordination with the Owner, of classroom and hands-on instruction which will cover the theory of operation, actual operation of the screens, optimization of the operation, electrical maintenance, instrumentation maintenance and mechanical maintenance shall be included.
- B. Manufacturer shall allow Owner to video tape any and all training at the Owner's discretion.

END OF SECTION 411213.36

## SECTION 462114 - MULTI-RAKE BAR SCREENS

### 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. Scope of Work
1. Furnish all labor, materials, equipment and incidentals required and install, test, complete and ready for operation, three (3) multiple rake type mechanically cleaned bar screens as indicated on the Drawings and as specified herein.
  2. Furnish and install all the unit(s) with all necessary accessory equipment and auxiliaries, whether specifically mentioned in this section or not, as required for an installation incorporating the highest standards for the type of service including field testing and instructing the regular operating personnel in the care, operation and maintenance of all equipment.
  3. Furnish variable frequency drives (VFDs) by the bar screen manufacturer, installed under this section in the master control panel and meeting the requirements of Section 262923 "Variable-Frequency Motor Controllers".
  4. Provide control panels for each Bar Screen with the ability to achieve operation specified herein and in Section 406196 "Process Control Descriptions."
- B. Section includes three multi-rake bar screens (mechanical bar screens) with 0.5-inch bar spacing, associated enclosures, controls, diverter chutes, and moveable platforms as described herein and as indicated on the Drawings.
- C. Related Requirements:
1. Section 099100 "Painting" for field painting.
  2. Section 406100 "Process Control and Enterprise Management Systems."
  3. Section 406121 "Process Control System Testing."
  4. Section 406196 "Process Control Descriptions."
  5. Section 406733 "Panel Wiring."
  6. Section 407816 "Indicating Lights."
  7. Section 407819 "Switches and Pushbuttons."
  8. Section 407853 "Relays."
  9. Section 411213.36 "Screw Bulk Material Conveyors" for screw conveyors.
  10. Mechanical piping and appurtenances, valves, pipe hangers and supports are included under Division 40.
  11. Electrical work, except as specified herein, is included under Division 26.

12. Wiring connections is specified in Section 260519 “Low-Voltage Electrical Power Conductors and Cables”.
13. Control panels are specified in Section 262505.00 “480V Control Panels”.
14. Electric motors are specified in Section 400593.23 “Low-Voltage Motor Requirements for Process Equipment”.

### 1.3 OPTION 1 & 2

- A. OPTION 1: Equipment specified herein is based on the Duperon Multi-Rake bar screen. Substitutions to the section with the Duperon FlexRake IQ will be held to the quality and minimum requirements described herein, and should be identified by the Contractor and additional costs from the base bid should be identified on the PRICING SHEET. All costs required to accommodate the proposed equipment will be borne by the Contractor and included under OPTION 1 on the PRICING SHEET.
  1. The General Bidder is required to provide a Bid for OPTION 1. If selected by Owner, the alternate will be ADDED to the Total Base Bid. The Bid for OPTION 1 includes the additional price of the General Bidder and all selected sub-bidders.
- B. OPTION 2: Equipment specified herein is based on the Duperon Multi-rake bar screen. Any substitutions to the section will be held to the quality and minimum requirements described herein, and should be identified by the Contractor and a deduct from the base bid should be identified on the PRICING SHEET. All costs required to accommodate the proposed equipment, including the time required by the Engineer, will be borne by the Contractor and at no additional cost to the Owner. Any exceptions to the requirements specified must be noted in the proposed OPTION 2 bid package.
  1. The General Bidder is NOT required to provide a Bid for OPTION 2. If selected by Owner, the OPTION will be subtracted from the Total Base Bid. The Bid for OPTION 2 includes the price deduction of the General Bidder and all selected sub-bidders.
- C. Include products and work included in this Section that are covered by cash or quantity allowance.

### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Arlington County WPCP.

### 1.5 ACTION SUBMITTALS

- A. Submit, in accordance with Section 013300 “Submittal Procedures,” copies of all materials required to establish compliance with this Section. Submittals shall include the following:
  1. Certified shop and erection drawings showing details, sizes, grades, protective coatings and materials of construction; dimensions; and any anchor bolt locations.
  2. Descriptive literature, bulletins, catalogs and local supplier of the equipment.



3. The total weight of the equipment including the weight of the single largest item or component, both when empty and when loaded with the maximum load of wet debris.
  4. Complete bill of materials for all equipment components.
  5. List of the manufacturer's recommended spare parts.
  6. Complete motor, drive and performance factor data in accordance with Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment".
  7. Details of the control panel, relays, wiring diagram, and in accordance with Section 262505.00 "480V Control Panels".
  8. Startup and testing procedures.
  9. Installation drawings including written procedure for installation of all equipment within the existing building and any removal and replacement details of the composite roof panels that may be necessary for proper installation.
  10. Drawings showing general dimensions and confirming the size of equipment including side seal height, motors and drives, anchor bolt locations, and piping connections
  11. Manufacturer's data including materials of construction, construction details of equipment, and lifting points. Provide thickness of critical individual parts to allow Engineer's assessment of relative durability of equipment among the various manufacturers.
  12. Factory testing results and certification (Preinstallation Testing).
  13. An experience statement with a list of the comparable screen installations including the correct name and telephone number of a contact person at each installation.
  14. Catalog data on all ancillary electrical components.
  15. Electrical requirements, schematic diagrams, and details of components included.
  16. Anchor bolt and mounting bolt design calculations and details.
  17. Range and setting of indicators, instruments, timers, and other related devices.
  18. Equipment warranty.
  19. Copy of the manufacturer's calculations showing that the frame and screen assembly can structurally handle the conditions specified within this Section.
  20. Instrumentation and control data as specified in Section 406100 "Process Control and Enterprise Management Systems General Provisions," including control narrative and control logic diagrams. Wiring diagrams shall include coordination and interface with other electrical and control equipment. Standard diagrams marked to indicate applicability to the Work are not acceptable.
  21. Draft and Final Operations and Maintenance Manual to the Owner in accordance with Section 017823 "Operation and Maintenance Data." The instructions shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, and descriptions necessary to instruct operating and maintenance personnel unfamiliar with such equipment. Installation drawings, wiring diagrams, and maintenance requirements shall all be included. Furnish for review by the Owner a draft version of the O&M Manual. Respond to Owner comments and furnish four final hard copies and two final electronic copies of final O&M Manual. Hard copies to be provided to the Owner in 3-ring binders.
- B. Manufacturers' certification of proper installation and operation as required in Part 3 Article, "Inspection and Testing."
- C. Product Data:
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

D. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of necessary by contractor to execute installation
4. Include diagrams for power, signal, and control wiring.
5. Submit a memory map to the Owner no later than 30 days prior to the scheduled shipment of the vendor equipment to the site.

E. Product Schedule.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: and other details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:
- B. Qualification Data: For manufacturer, and fabricator, factory-authorized service representative.
- C. Seismic Qualification Certificates: For screens, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Welding certificates.
- E. Material Certificates for screens, enclosures and diverter gates.
- F. Product Test Reports: For each screen, for tests performed by manufacturer..
- G. Evaluation Reports from ICC-ES.
- H. Preconstruction Test Reports.
- I. Source quality-control reports.
- J. Field quality-control reports.
- K. Sample Warranty.

## 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Include in maintenance manuals.
- B. Operation and Maintenance Data: Include in operation and maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Provide spare parts for the equipment, including the following spare parts as a minimum (all parts to include associated mounting hardware):
  - 1. Two (2) complete rake assemblies per screen.
  - 2. One (1) upper sprockets and bearings.
  - 3. One (1) lower sprockets and bearings, if applicable.
  - 4. Six (6) wipers for scraper.
- S. Manufacturer shall provide any specialty tools and recommend spare parts required for maintaining the equipment as follows:
  - 1. Drive Clevis Pin (1)
  - 2. Snap/Retaining Rings (10)
  - 3. Link Clevis Pins (4)
  - 4. Scraper Bolts (4)
  - 5. Scraper Nuts (4)
  - 6. Snap Ring Tool (1)
  - 7. Never Seez, 1 oz. tube (1)
- T. Manufacturer shall provide one tube of Multi-Purpose grease which is a 5-year supply of lubrication, required for maintaining all bar screen components.
- B. Pack all spare parts for long-term storage in an unheated, unventilated, damp area in containers which are clearly identified on all sides with indelible markings as to contents.

#### 1.9 QUALITY ASSURANCE

- A. To assure quality and performance: All equipment furnished under this Section shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the equipment and demonstrates, to the satisfaction of the Engineer, that the quality is equal to equipment made by the manufacturer specifically named herein. And the screen manufacturer shall have at least 25 installations of the specified model of mechanically cleaned bar screen equipment that has been in successful operation, at similar installations, for at least five (5) years. Upon request, the manufacturer shall provide a reference of such installation sites along with the relevant contact information.
- B. Manufacturer shall have established an ISO 9001 certified quality management system or similar quality management program.
- C. Multiple rake bar screens shall be manufacturer's standard product and only modified as necessary to comply with the Drawings, Specifications, and specified service conditions. Manufacturer shall provide multiple rake bar screens, motors, gear reducers, controls, control

panels and local control stations, variable frequency drives and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

- D. The mechanical screen shall be suitable for satisfactory operation within the maximum and minimum screen channel water levels specified herein.
- E. All structural members of the equipment shall be designed for shock and vibratory loads.
- F. Each multiple rake bar screen shall have the manufacturer's name, address and product identification on a nameplate securely affixed to the equipment.
- G. Services of the Manufacturer's Representative
  - 1. The equipment manufacturer shall furnish the services of a competent and experienced factory representative who has complete knowledge of proper installation, operation and maintenance of the equipment to inspect the installed equipment, provide vendor training to plant personnel in operation and maintenance of the equipment, perform an initial test run and conduct final performance testing.
    - a. Two 8-hour day per screen (excluding travel time) to supervise the erection and adjustment of the equipment, final alignment, and to certify its readiness for operation
    - b. Four 4-hour training sessions delivered on different dates, per coordination with the Owner, following the installation of the first screen. Each training sessions shall be 2-hours classroom and 2-hours field. These instruction sessions shall be scheduled at least ten days in advance with the OWNER and shall take place prior to plant start-up and acceptance by the OWNER. The final approved copies of operation and maintenance manuals must have been delivered to the ENGINEER and OWNER prior to scheduling the instruction period with the OWNER. Additionally, four 2-hour training sessions delivered on different dates, per coordination with the Owner, following the installation of the last screen.
    - c. Minimum two 8-hour days per screen (excluding travel time) to conduct functional testing of the system dry
    - d. Minimum seven 8-hour days per screen to perform the initial test run on process fluid and conduct final performance testing.
  - 2. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or CONTRACTOR's installation, additional service shall be provided at no change in Contract Price or Time.
  - 3. Manufacturer representative to be on-site for coordination and programming support with Owner Staff. Provide three 8-hour days on-site.
- H. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel, D1.3, "Structural Welding Code - Sheet Steel, and D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."
- I. Ship in as few parts as possible, requiring minimum onsite assembly.
- J. Provide lifting eyes or lugs to allow easy installation of the unit into the waiting screen channels.

- K. Furnish all special tools required for normal operation and maintenance of the equipment.

#### 1.10 WARRANTY

- A. Manufacturer shall provide a written one year standard warranty from the date of use of the mechanically cleaned bar screen equipment to guarantee that there shall be no defects in material or workmanship in any item supplied.
- B. The Contractor shall obtain from the manufacturer its warranty that the equipment shall be warranted for a period of one year from the date of Substantial Completion startup and beneficial use, as defined in the General Conditions, Division 00 and specified in Section 01740, to be free from defects in workmanship, design or material. If the equipment should fail during the warranty period due to a defective part(s), the part(s) shall be replaced in the equipment and the unit(s) restored to service at no expense to the Owner.
- C. Manufacturer shall warrant for the period of five years from the date of Substantial Completion all rotating parts of the Mechanically Cleaned Bar Screen including the gear motor, bearing, drive head, and the link system including the links, castings, pins and retaining rings. Manufacturer warrants that these components shall be replaced if damaged or defective in the normal use of the equipment.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Equipment and accessories shall be provided in conformance with the area classification requirements of the room in which the equipment shall be placed. Classification requirements are indicated in the area classification Drawings.
- B. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.
- C. The mechanically cleaned bar screen shall be designed for passively resisting corrosion from chlorides, hydrogen sulfide, condensation containing sulfuric acid residual, and sulfates. The materials of construction shall meet or exceed the following:
- D. Screen shall be manufactured from AISI 304 stainless steel shapes (rods, angles, and channels), pipes, and sheets. In particular, side frames and guides, bar rack, rake (scraper) assembly, shafting, discharge chute, enclosure, fasteners (bolts & nuts, etc.), and anchor bolts shall be made of this material.
- E. Screen shall be manufactured either in a stainless steel only factory to prevent contamination of the stainless steel with ferric oxide dust, or in a factory that has measures in place to prevent contamination of stainless steel with ferric oxide dust. Submit measures utilized to prevent contamination.

- F. All stainless-steel components and structures shall be at a minimum cleaned, descaled, and passivated in accordance with ASTM A380.
- G. The bar screens shall be provided with a dead plate extending from the bar rack to the discharge chute. The dead plate shall be securely fastened to the side frames.
- H. Screenings transported to the top of the screen shall be discharged positively by means of a rake cleaning mechanism to the discharge chute. A stainless steel and UV Stable UHMW-PE debris blade assembly shall be provided to assist in removing debris from the scraper.
- I. A discharge chute shall be provided that fully encloses the discharge section of the screen to the point of screenings discharge. The discharge chute shall be mounted to direct screenings into the both shaftless screw conveyors with a diverter gate mechanism to feed either conveyor. Access hatches with hinges and handles shall be provided in the chute permitting easy access, as indicated on the drawings.
- J. A frame shall be provided supporting all required loads during installation and final operation. The side frames shall be connected to support frames. The support frames shall be securely anchored onto the operating floor.
- K. The screen shall be provided with easily removable, sufficiently stiffened covers for total containment of odorous and corrosive gases emanating from the screen. The covers shall be provided with handles and shall be fastened in such a manner to allow for installation and removal without utilizing hand tools. The covers will extend the full width and height of the screen above the operating deck.
- L. Drive link type screens: Screens shall be provided with two sprockets. The sprockets shall be made of 304 stainless steel plates.
- M. Drive link type screens: Drive links shall be made of 304 stainless steel with 304 stainless steel pins and 302SSTL snap (retaining) rings. Drive links, link slides, sprockets and their bearings shall be replaceable without the need for removing the screen from the channel.
- N. The rake mechanism shall be capable of two cleaning speeds: Low and High, in addition to varying speeds by means of variable frequency drive. Refer to Section 406196 "Process Control Descriptions" for operating description.
- O. All the mechanical bar screening equipment shall be assembled in the manufacturer's shop to ensure proper fitting of parts, the control panel shall be pre-wired, tested and then match-marked for erection, and disassembled for shipment.

## 2.2 DETAILED COMPONENT SPECIFICATIONS

### A. Bar Rack

- 1. The bar rack shall consist of teardrop shaped bars constructed of 316 stainless steel material with a minimum upstream dimension of 0.25 inch, a minimum downstream dimension of 0.13 inch, and a minimum depth of 0.75 inch with required clear spacing between the bars. Trapezoidal or round bars shall not be used.

2. A stainless steel channel bottom plate shall be an integral part of the bar screen assembly to fully engage scrapers at the base of the unit and assure that the raking mechanism cleans the bottom of the screen to prevent debris accumulation.
3. The bar rack shall consist of equally spaced, straight bars that are inclined from the horizontal with the inclination angle specified above and shall span the full width of the channel. The bar rack shall be securely fastened to and supported by the frame of the screen, and be readily removable. Bars that are welded to the framework shall not be allowed. Replacement screen bars shall be available from the screen manufacturer.
4. Bars shall be fastened to a dead plate that extends to the point of discharge. Bars shall extend to the top of the screen channels as a minimum.

B. Welding:

1. All welding shall conform to AWS D1.6 or AWS D1.1, as applicable. Weld spatter shall be prevented by the use of spatter-prevention paste at welded joints. Weld slag shall be removed.
2. After welding operations, stainless steel components shall be cleaned of organic contamination using a solvent that is free of chlorides.
3. Welded ferrous or steel components shall be provided with continuous seal welds between full penetration skip welds or sealed with a paintable silicone caulk.
4. Field welding of stainless steel will not be permitted.

C. Frame Assembly:

1. The framework of the screen shall have a cross-section with a minimum thickness of 6 mm. The side frames shall have a minimum thickness of 6 mm formed to a channel profile. Horizontal members shall be of stainless steel bent plate or stainless steel pipe. Support members and frame shall adequately support the bar screen based on the site specific requirements.
2. The supporting framework for the bar screens shall be constructed of material specified in Part 2 Article "General." Shop connections may be welded, riveted, or bolted.
3. All structural members and connections shall be designed so that the unit stresses will not exceed AISC allowable stresses by more than 1/3 when subject to loading of twice the running torque of the drive motor.
4. The support framework shall be designed and constructed such that the screen is independently supported, to allow the bar screen to be installed and disassembled without disturbing existing equipment.
5. Supports shall be installed using welded constructions with bolted connections to bar screen casings, feet and support points. Field connections shall be bolted using reamed, subpunched holes and finished bolts as follows:
  - a. Supporting members attached to concrete shall be by stainless steel anchor bolts. A minimum of two bolts shall be used per supporting member.
  - b. Supporting members attached to structural steel elements shall be by stainless steel hex bolts with one flat washer and one lock washer. A minimum of two bolts shall be used at each connection point.
6. The screen design shall utilize structural side frames to which are bolted the bar rack and dead plate resulting in a structurally self-supporting unit. Designs in which side frames or chain guides are supported from the channel walls shall not be acceptable.

7. Return guide/closeouts shall be stainless steel and shall assure proper alignment of scrapers as they enter the bar screen and assure that there is no space wider than the clear opening between bars to prevent passage of larger solids than allowed through the screen.
8. Lifting lugs shall be provided on the side frames as recommended by the screen manufacturer.
9. Link slides shall be provided and shall be constructed of UV stable UHMW PE rollers and stainless steel supports and components.
10. Screen Enclosure: A 14ga. #4 brushed satin finish 304 stainless steel Enclosure shall be installed to completely cover and encompass the screen on the second floor and mezzanine levels of the PTB building. The top of the enclosure shall include 6-inch flanged connection with blind flange for future odor control duct connection. The enclosure shall include all hatches as indicated on the Drawings and described herein. 14 ga. #4 brushed satin finish 304 stainless steel side shields will be provided on the first floor.
11. Frame assembly shall be equipped with tie-off points on the First Floor, Second Floor and Mezzanine level near the screen channel and enclosure access hatches.

D. Rakes:

1. The rakes shall be mounted between two (2) link assemblies running over one (1) set of sprocket wheels.
2. Scrapers: Scrapers shall be spaced 21 inches apart. To provide long product life the scraper shall move at no greater than 28 inches per minute at standard operating speed of 1/2 rpm allowing for approximately 1 debris discharge per minute. Staging Scrapers and Thru Bar Scrapers shall be a maximum ratio of 3:1 per manufacturer recommendations. At least one scraper every 84 inches shall fully penetrate the bar screen, cleaning all three sides of the bars as well as through to the cross members in openings of 0.25, 0.375 and 0.50 inches.
  - a. Staging Scrapers; Staging Scrapers shall be 1 inch thick x 4 inches x screen width UV Stable UHMW-PE with a serrated edge.
  - b. Thru Bar Scrapers: Thru Bar Scrapers shall be minimum 0.375 inch thick x 5 inches x screen width 304 stainless steel.
3. OPTION 1: Duperon FlexRake IQ rakes (scrapers) shall be minimum 0.25 inch thick x 4.2 inches x the screen width, 2205 Super Duplex stainless steel.

E. Rake Wiper:

1. A pivoting wiper mechanism shall be positioned at the point of discharge and shall have a replaceable ultra high molecular weight polyethylene (UHMW-PE) wiper blade, with a minimum thickness of 6 mm.
2. The wiper mechanism, excluding the wiper blade, shall be manufactured of 304 stainless steel. No moving parts shall extend beyond the framework or the discharge chute.
3. The design shall be such that the rake repositions the wiper mechanism. The wiper mechanism design shall allow the rake assembly to be operated in jog-reverse from the operator deck observing the wiper mechanism.

F. Rake and Chain Assembly, Rake and Link Assembly, and Sprockets



1. The rake and link assembly shall consist of multiple rakes attached to the links. The pin shall engage onto adjustable upper sprockets on each side of the screen.
2. The upper sprockets shall be made of 304 solid stainless steel. The sprockets shall be of the pitch and width to match the links/pins and shall have a 304 stainless steel hub and sprocket teeth.
3. The link system shall be such that it bends in one direction only, which allows it to become its own lower sprocket and frame. The link system shall also have the ability to flex around a large object such as a drum, tire, grease ball wooden 2"x4"x4', etc. without overload to avoid shutting down the unit.
4. Drive link type screens: The links shall be of 304 stainless steel material with 304 stainless steel pins. The link system shall be passivated meeting ASTM A380 specification for surface finish.. The links shall have an ultimate strength of 60,000 pounds, and shall have 1,000 pound lifting capacity.

G. Shafting and Bearings:

1. The drive shaft shall be made of solid stainless steel, fitted with a shear pin device with bronze bushing, or auto reverse feature, to provide full protection of the drive unit. Keyways with fitted keys will be provided where necessary.
2. Upper bearings shall be flange bearings, and shall be provided with grease nipples for easy lubrication. The bearings shall be designed for use with biodegradable grease. Sealed self-lubricating upper bearings may be utilized.
3. No lower bearings will be allowed.

H. Dead Plate:

1. The dead plate shall be fastened to the side frames of the screen, and shall extend from the top of the bar rack to the point of discharge. A stainless steel lip shall be provided at the discharge point of the dead plate.
2. The dead plate shall be made of 304 stainless steel having a minimum thickness of 6 mm.

I. Discharge Diverter Chute:

1. A discharge chute shall be provided to guide the debris from the lip at the top of the dead plate to the screw conveyors specified in Section 411213.36 "Screw Bulk Material Conveyors" and as indicated on the Drawings. A full discharge chute enclosure shall be provided. The discharge chute and enclosure shall be manufactured of the material specified in Paragraph 2.1, shall have a minimum thickness of 4 mm, and shall be provided with access doors, with a handle, to facilitate wiper replacement.
2. The discharge chute shall have a maximum angle of 30 degrees from vertical and shall direct screenings into two shaftless screw conveyors with a diverter gate mechanism
3. Diverter plate inside the chute shall have a UHMW PE liner on both sides the prohibit screenings from sticking to the diverter plate. Any fasteners should be recessed such that rags will not catch on them.
4. The diverter plate shall be actuated with an extended operator so County staff can position the diverter plate as desired without leaning over the screw conveyors. The actuator shall be lock-able and provided with a two-position indicating limit switch rated for Class 1 Division 2 service that will connect to SCADA so staff can see the position of the diverter plate inside the chute from SCADA.

5. The diverter chute shall be fabricated with flanges on the top and bottom that can be gasketed and bolted to the screen enclosure and screw conveyor covers.
6. The divert assemblies shall be manually operated. The blade assembly and pivot shall be supplied with serviceable bearings on each side of the main housing. No more than 30lbf shall be required to manually operate through the full range of positioning, while screenings are inside the chute.

J. Drive Unit:

1. The drive assembly shall be complete with an adjustable mounting frame, motor, and gear reducer.
2. The motor shall be explosion proof and shall be as specified in Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment".. Motor shall be inverter duty rated and compatible for use with VFD furnished to speed control the bar screen.
3. The drive unit shall be assembled by the manufacturer and shipped as a complete assembly to ensure proper assembly of all components.
4. The drive unit shall be designed for continuous service and intermittent spray water contact.
5. Gearbox shall be shaft-mounted, right angle type and include spiral bevel gearing. The output shaft speed shall be controlled by a vector type inverter or per rake manufacturer's recommendation. It shall have at least a 1.52 or greater service factor based on machine torque requirements. The gearbox shall not be vented to the outside atmosphere. The gearbox shall be grease filled. Oil filled gearboxes are not allowed.
6. The motor shall be AC induction type, inverter duty, 3 phase 240/480 volt and mounted to the gear reducer. The motor shall be ½ hp, designed for 1800 RPMs base speed and rated for Class I, Groups C & D, Class II Groups F & G environments. The motor shall have an EPNV enclosure, NEMA design B with a 56C frame size. Service factor shall be 1.0 or greater, Class F insulation and be optimized for IGBT type inverters. The motor must be UL listed and designed for continuous operation.
  - a. Motor shall have built in, normally closed, thermostat to protect from overheating that is to be field wired to corresponding terminal in control panel for redundant (ambient) overload protection.
  - b. All drive head components shall be of components available in the United States.
7. Bearing: Bearing shall be greased ball bearing type, non self-aligning, sealed and lubricated and shall have a 24/7/365 L10 life of 20 years when in compliance with stated O&M recommendations. Non-sealed bearings are not acceptable.
8. Speed Reducer: Speed reducer shall be a double-reduction, cycloidal style and shall comply with all applicable AGMA standards. The speed reducer shall be capable of a 4/1 speed range with variable output speeds between 0.50 to 2.2 output RPMs (in high flow conditions). The speed reducer shall produce an output torque of 11,417 in.lb. and have a gear ratio of 809:1.
9. OPTION 1: The motor shall be 1 hp and otherwise comply with all other details of this section.
10. OPTION 1: Speed reducer shall be a double-reduction, cycloidal style and shall comply with all applicable AGMA standards. The speed reducer shall be capable of a 6/1 speed

range with variable output speeds between 0.69 to 4.13 output RPMs (in high flow conditions). The speed reducer shall produce an output torque of 11,000 in.lb. and have a gear ratio of 424:1.

## 2.3 ANCHOR BOLTS

- A. All anchor bolts required for the installation of the equipment shall be furnished by the equipment manufacturer. Anchor bolts shall be Type 316 stainless steel. Anchor bolts shall be ample size and strength for the purpose intended.

## 2.4 HATCHES

- A. Access hatches shall be provided as indicated on the Drawings and shall be provided with 316 stainless steel hinges, handles, latches and all other hardware. Hinges shall be bolt-on such that they can be disassembled, and doors removed if necessary. Hatches shall be designed by the manufacturer such that they are OSHA compliant. Each shall be provided with neoprene gaskets minimum 1/8-inch thick around the perimeter of each opening. Hatch doors shall be reinforced as recommended by the manufacturer to prevent deflection while open or closed.
  - 1. Access hatches on diverter gates at the PTB Second Floor shall be provided without latches, such that the hatches can swing open if diverter gates are blocked.
  - 2. Access hatches on top of the screen enclosure at the PTB Mezzanine shall be a latched cover plate with no hinges.

## 2.5 CONTROLS

- A. Description:
  - 1. The Barscreens will remove screenings from the PTB influent. Typical operation will be two Barscreens operating at all times. The Barscreens will run at low or high speeds depending on the PTB influent and channel levels.
  - 2. The Bar Screens can be set to run in automatic mode from the PCS. Each Bar Screen will receive a run command from PCS when the respective channel is brought online and will run at variable two speeds based on the PTB influent channel level monitored by two non-contact radar level transmitters. Level will be used for Bar Screen operation as described in Section 406196 "Process Control Descriptions." If the channel high-level float switch is tripped, the downstream Bar Screen will run at maximum speed.
  - 3. In the event of a motor overload, the Bar Screen motors can be reset from the VFD in the panel room.
  - 4. Refer to Control Logic per Section 406196 "Process Control Descriptions" for coordination with plant control system.
- B. One VFD panel shall be provided for each Barscreen located in the panel room in a NEMA 12 steel enclosure.
  - 1. Refer to the P&IDs for requirements for control panel layout requirements (i.e. lights, switches, indicators) and I/O signals to plant control system.

- C. One local control panel shall be provided with local controls for each Barscreen:
1. Control panel construction, devices, and wiring shall comply with the control panel construction requirements of Section 262505 “480V Control Panels.” Instrumentation shall comply with the requirements of Sections 407000 “Instrumentation for Process Systems” and shall be suitable for Class I, Division II hazardous locations. The panel shall be provided with 480-volt power circuit as indicated on the drawings.
  2. Panel enclosure shall be skid-mounted of NEMA 7 suitable for a Class I, Division II, Group D hazardous location. Panel shall have front access and shall be amply sized to suit the equipment furnished without crowding.
    - a. Wiring shall be completed in accordance with Divisions 26 and 40. Wiring shall comply with the latest edition of the National Electrical Code.
    - b. The enclosure shall house a transformer for control power and all starters, contactors, timers, switches, relays, alarms, indicating lights, and operator controls for operation of the system.
  3. Refer to the P&IDs for requirements for control panel layout requirements (i.e., lights, switches, indicators) and I/O signals to plant control system.
- D. Miscellaneous
1. Provide high motor temperature switch for each Barscreen as indicated on the drawings. Instrumentation shall be suitable for Class I, Division 2 hazardous locations.
  2. Provide one Emergency Pull Cord device for each Barscreen. Contractor to install pull cord on new equipment guardrails on first floor as indicated on the drawings. When pulled, the Barscreens shall stop and trip the ‘Emergency pull cord switch actuation’ signal.
  3. Provide one Emergency Stop pushbutton for each Barscreen. Contractor to install pushbutton on screens on second floor as indicated on the drawings. When pushed, the Barscreens shall stop and trip the ‘Emergency stop actuation’ signal.

## 2.6 SOURCE QUALITY CONTROL

- A. Prior to shipment, each bar screen shall be fully assembled and operated at the factory at its required operating angle of inclination prior to shipment. Match mark mating parts prior to disassembly for shipping.
- B. Factory Tests (Pre-installation Testing): Factory assembled and factory test the screen for a minimum of 4 hours run time before being shipped. Test to verify that the screen meets the Design Requirements.
1. The Owner and Engineer reserve the right to be present during the factory testing.
  2. Notify the Owner and Engineer at least 42 days prior to the estimated test date. Owner and Engineer will cover their traveling expenses.

## 2.7 SHOP FINISHES

- A. Prepare and shop prime all exposed surfaces as specified in Section 099100 “Painting.”

## 2.8 MANUFACTURERS

- A. Products: Subject to compliance with requirements, the equipment and accessories provided under this Section shall be the FlexRake® Model from Duperon Corporation located at 1200 Leon Scott Court, Saginaw, MI 48601. Provide the following:
1. Duperon Multi-rake 0.5-inch bar screen.

## 2.9 SYSTEM DESCRIPTION

- A. Bar screens shall remove screenings from municipal wastewater and discharge the screenings into one of two shaftless screw conveyors via a dedicated diverter gate mechanism. No screening of any kind is upstream of the multi-rake bar screens being provided under this section. The bar screen shall be front cleaning/front return with multiple rakes entering the bar rack from the upstream side of the screen and discharge screenings above the operating floor onto a chute on the downstream side of the screen. The screens will be located indoors where the temperature range will be between 50 and 90 degrees F. The wastewater will have a temperature of 50 to 90 degrees F. Back cleaned screens, single rake screens, or perforated plate screens employing brushes and spray water to remove screenings shall not be acceptable.

- B. Each screen shall be furnished and installed in conformance with the following data:

- |   |          |
|---|----------|
| 1. Number of units  | 3        |
| 2. Channel width, ft-in   | 8'-0"    |
| 3. Channel depth (channel base slab to PTB lower operating level), ft-in.   | 9'-0"    |
| 4. System Average Daily Flow, mgd   | 40.0     |
| 5. System Peak Hourly Flow, mgd   | 88.0     |
| 6. Maximum flow per screen, mgd   | 50.0     |
| 7. Normal water depth at average daily flow flow, ft  | 3.2**    |
| 8. Maximum operational water depth at peak hourly flow, ft  | 4.0**    |
| 9. Maximum blinding, percent  | 25%      |
| 10. Screen inclination from horizontal, degrees   | 80       |
| 11. Clear spacing between screen bars   | 1/2-inch |
| 12. Motor size, Hp  | 1/2 Hp   |
| 13. Normal motor speed, (rpm)   | 1800     |
| 14. The equipment specified herein is intended to be standard equipment for use in a screenings removal system, specifically to separate larger, solid and semi-solid debris and floating matter from raw wastewater. |          |

\*Dimensions to be field verified by manufacturer prior to fabrication.

\*\*Assumes two screens in operation with 25% blinding each

- C. Each multi-rake bar screen shall collect and remove solid and fibrous material from raw wastewater. Each multi-rake bar screen shall include a frame, housing, bars, rakes, drive element, seals, cleaning mechanisms, gear reducer, motors, mounting fixtures, associated instruments, and all necessary appurtenances to provide a complete and operable unit.

- D. Coordinate the screenings discharge chute and diverter gate mechanism with the receiving shaftless screw conveyors to assure proper and safe operation, easy access to all equipment items for routine maintenance, and that the screenings and associated moisture are deposited completely within the receiving equipment.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.10 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 400593.23 “Low-Voltage Motor Requirements for Process Equipment”.

## 2.11 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Finish products after assembly.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Installation and initial lubrication shall be in strict accordance with the manufacturer's instructions and recommendations in the locations indicated on the Drawings. Installation shall include furnishing any required oil and grease for initial operation. Anchor bolts shall be set in the concrete in accordance with the manufacturer's recommendations.

### 3.2 FIELD PAINTING

- A. Field Painting is included in Section 099100 “Painting.”

### 3.3 INSPECTION AND TESTING

- A. The manufacturer's representative shall inspect the final installation and supervise a test run of the equipment.
- B. The manufacturer shall certify in writing that the screen has been properly installed and is operating correctly.
- C. The factory representative, in the presence of the Owner, shall perform dry field tests on the mechanical screen as follows:

1. Perform a dry test run of the screens upon final installation to demonstrate the correct alignment, smooth operation, proper and equal spacing of screen bars, all instruments are communicating correctly with SCADA, freedom from vibration, absence of excessive noise and overheating of the parts and bearings. Each screen shall operate for 24-hours continuously during the dry test.
2. An overload torque test shall be conducted to test the torque overload device to operate and stop the bar screen at a loading condition equal to 150 percent of the actual working load to protect the drive unit. Test procedures shall be as recommended by the manufacturer and shall be submitted for review.
3. The necessary adjustments and settings to the torque overload device shall be made by the factory representative to ensure that the mechanical screen will stop, switch off the drive motor and sound an alarm when a predetermined overload condition occurs on the screen bars.
4. All defects recorded during the above field tests shall be corrected by the supplier.
5. In the event the mechanism fails to meet the above test, the necessary changes shall be made and the mechanism retested. If the mechanism remains unable to meet the test requirements to the satisfaction of the Owner, it shall be removed and replaced with a satisfactory mechanism at no additional cost to the Owner.

D. The factory representative, in the presence of the Owner, shall perform performance testing on the mechanical screens as follows:

1. Upon completion of the dry test, perform performance tests with process fluid to demonstrate that the screens performance confirms to this Section. It shall be demonstrated that the screens control system repeatedly performs as specified. Each screen shall operate for 7 days continuously (minimum 8 hours at max available flow up to 50 MGD each). Performance testing shall be scheduled around a storm of minimum ¾" precipitation.

E. Acceptance Testing: Upon satisfactory completion of the performance testing.

1. Acceptance period shall be thirty days of continuous operation for the first bar screen in service. For the second and third bar screens, the acceptance period shall be seven days of continuous operation. Manufacturer shall be available on-call and on-site within 24-hour notice, as needed during acceptance period.

### 3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.5 ADJUSTING

A. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.

B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.6 PROTECTION

- A. Remove and replace products or materials that are wet, moisture damaged, or mold damaged.

### 3.7 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include six months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative that is an employee of the manufacturer to train Owner's maintenance personnel to adjust, operate, and maintain units. Local sales representatives will not be an acceptable substitute for a manufacturer's service representative. Provide four 4-hour sessions on different dates, per coordination with the Owner, of classroom and hands-on instruction which will cover the theory of operation, actual operation of the screens, optimization of the operation, electrical maintenance, instrumentation maintenance and mechanical maintenance shall be included, following the installation of the first screen. Provide four 2-hour sessions on different dates, per coordination with the Owner, of classroom and hands-on instruction following the installation of the last screen.
- B. Manufacturer shall allow Owner to video tape any and all training at the Owner's discretion.

END OF SECTION 462114



## SECTION 462173.13 – SCREENINGS WASHER AND COMPACTOR

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Furnish two washing and compaction systems including all labor, materials, equipment, and required incidentals. This work includes the installation and testing of a system that is complete and ready for operation. This system includes two screenings washer-compactors, motor controllers, control panels and appurtenant equipment as shown on the Drawings and as specified herein.
2. Electric motors shall be furnished as part of the work of this Section and shall conform to all applicable portions of Section 400593.23 “Low-Voltage Motor Requirements for Process Equipment”.
3. The units shall be furnished and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in this Section or not, as required for an installation incorporating the highest standards for the type of service including field testing and instructing the regular operating personnel in the care, operation and maintenance of all equipment.
4. Each washer-compactor shall come with a Main Control Panel. The Main Control Panel shall come equipped with a motor starter, and all ancillary equipment needed to make the control system a functional unit.
5. Each washer-compactor shall come with a Local Control Panel for operation locally at the equipment.
6. Each screenings washer-compactor shall receive screenings from the three Bar screens with 0.5-inch spacing. Wet screening will be conveyed from the screens by a shaftless screw conveyor to the washer-compactors as shown on the Drawings. Washed and compacted screenings shall be conveyed by the washer-compactor to a chute leading to a dumpster for ultimate disposal.

- B. Related Work

1. Concrete work is included in Division 03.
2. Surface Preparation and Painting is included in Division 09.
3. Section 099100 “Painting” for finish painting.
4. Section 260505.00 “480V Control Panels”.
5. Section 262716.00 “Electrical Cabinets and Enclosures”.
6. Section 406100 “Process Control and Enterprise Management Systems.”
7. Section 406121 “Process Control System Testing.”
8. Section 406196 “Process Control Descriptions.”

9. Section 406733 "Panel Wiring."
10. Section 407816 "Indicating Lights."
11. Section 407819 "Switches and Pushbuttons."
12. Section 407853 "Relays."
13. Mechanical piping, valves, pipe hangers and supports are included in the respective sections of Division 40.
14. Electrical work, except as specified herein, is included in Division 26.
15. Bar Screens are included in Div 46.
16. Shaftless Screw Conveyors are included in Div 41.

### 1.3 SUBMITTALS

- A. Submit, in accordance with Section 013300 "Submittal Procedures," copies of all materials required to establish compliance with this Section. Submittals shall include the following:
  1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.
  2. Descriptive literature, bulletins and/or catalogs of the equipment.
  3. All information required by Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment".
  4. The total weight and dimensions of the equipment including the weight and size of the single largest item or component.
  5. A complete total bill of materials for all equipment.
  6. A list of the manufacturer's recommended spare parts.
  7. Recommended grade of lubricants along with alternative references to equal products of other manufacturers.
  8. Documentation of the AGMA rating of the drive assembly.
  9. Details of the torque overload device.
  10. Complete data on motor and power factor correction capacitors (if required) in accordance with Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment".
  11. Complete description of surface preparation and shop prime painting.
  12. Equipment instrumentation and control description.
  13. Submit a memory map to the OWNER no later than 30 days prior to the scheduled shipment of the vendor equipment to the site.
  14. All information required by Section 262505 "480V Control Panels".
- B. In the event that it is impossible to conform to certain details of this Section, describe completely all non-conforming aspects.
- C. Operating and Maintenance Data.
  1. Operating and maintenance manuals shall be furnished to the Engineer as provided in Section 017823. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions that are required to instruct operating and maintenance personnel unfamiliar with such equipment.
- D. The Contractor, prior to installation of any new Work in the Preliminary Treatment Building (PTB), shall submit to the Engineer detailed layout drawings of the entire PTB for approval. The

detailed layout drawings shall show all proposed equipment as it is intended to be installed by the Contractor. The drawings shall include, but not be limited to:

1. Actual dimensions of all proposed equipment from the Contractors selected manufacturer.
2. Noted deviations from the original Contract Documents.
3. Detailed dimensions between new equipment and existing structures, piping, valves, and other appurtenances.
4. Other pertinent information that is recommended by the Manufacturer.

#### 1.4 QUALITY ASSURANCE

##### A. Qualifications.

1. The equipment specified herein shall be furnished by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The washer-compactor shall be suitable for satisfactory operation within the performance criteria specified herein. The manufacturer shall submit documentation demonstrating experience in design, manufacture and start-up of washer-compactor equipment of similar capacity at a minimum of three wastewater treatment facilities each of which has been operating in the United States for 5 or more years.

##### B. Certifications.

1. Certify that materials and equipment specified herein conform to the respective standards referenced.
2. Certify that shop test equipment has been calibrated.
3. Certify that field test equipment has been calibrated and checked.

##### C. Services of manufacturer's representative.

1. Provide services of a manufacturer's service engineer specifically trained on the type of equipment specified, as required in Section 01 73 00. Submit qualifications of the service engineer for approval. Work-day requirements listed below are exclusive of travel time and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.
2. Installation.
  - a. One 8-hour day per washer/compactor, exclusive of travel time, of on-site installation assistance in locating anchor bolts, setting, leveling, aligning, etc. for installation and in coordinating piping, electrical and miscellaneous utility connections.
3. Operations & Maintenance Training.
  - a. Provide four 4-hour sessions on different dates, per coordination with the Owner, of classroom and hands-on instruction which will cover the theory of operation, actual operation of the screenings washer/compactor, optimization of the operation, electrical maintenance, instrumentation maintenance and mechanical maintenance shall be included.

- b. Manufacturer shall allow Owner to video tape any and all training at the Owner's discretion.
4. Functional Testing
  - a. Minimum one 8-hour days per washer/compactor to conduct functional testing of the system dry.
5. Performance Testing
  - a. Minimum one 8-hour day per washer/compactor to conduct functional testing of the system with screenings.
6. Service Inspections.
  - a. Two days (not anticipated as consecutive) for service inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls.
7. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or contractor's installation, additional service shall be provided at no change in Contract Price or Time.
8. Manufacturer representative to be on-site for coordination and programming support with Owner Staff. Provide three 8-hour days on-site.

## 1.5 SYSTEM DESCRIPTION

- A. Screenings collected from 1/2-inch bar screens will be discharged into a shaftless screw conveyor and be conveyed to the washer-compactors where it will be processed through a mechanically operated screenings compactor, pushed through a discharge tube/pipe, discharged into a screenings drop chute and collected into a container for appropriate off-site disposal. The screenings, will include scum, fats, oils and grease (FOG), grit, long fibers, and any other inert or organic materials that may enter the plant from a combined collection system servicing a major metropolitan area, will all be fed to the washer-compactor.
- B. Washer compactor shall be furnished and installed in conformance with the following data:

### Washer-Compactor:

- |  |                 |
|--|-----------------|
| 1. Number of Washer Compactors                                     | 2               |
| 2. Minimum Input Capacity of Raw Screenings (Continuous)           | 90 cf/hr        |
| 3. Minimum Input Capacity of Raw Screenings (Batch, if applicable) | 30 cf/hr        |
| 4. Compactor Discharge Height                                      |                 |
| i. Above Grade (min - max)   | See drawings    |
| 5. Maximum Flow and Pressure Required                              | 45 gpm @ 60 psi |

- |                                 |         |
|---------------------------------|---------|
| 6. Perforation Size (max):      | 6 mm    |
| 7. Minimum Hopper Clear Opening | 48-inch |

\* Contractor to verify all dimensions. Footprint of washer/compactor as indicated on the drawings and to be coordinated with Bar Screen and Shaftless Screw Conveyor manufacturers.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Delivery and storage of the washer compactors shall be in accordance with Section 016000.

## 1.7 MAINTENANCE

- A. Tools and Spare Parts.

1. One set of special tools required for normal operation and maintenance shall be furnished with the equipment.
2. Provide one full set of all manufacturer's recommended spare parts shall be provided for the furnished washer compactor to ensure that the plant operations will be less impacted during downtime.
3. All tools and spare parts shall be furnished as specified in Section 017300.

## 1.8 WARRANTY

- A. The Contractor shall obtain from the manufacturer its warranty that the equipment shall be warranted for a period of two (2) years from the date of Substantial Completion, as defined in the General Conditions, Division 0 and specified in Section 017700, to be free from defects in workmanship, design and materials. If the equipment should fail during the warranty period due to a defective part(s), the part(s) shall be replaced in the equipment and the unit(s) restored to service at no expense to the Owner.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Screenings shall be conveyed to the inlet hopper via shaftless screw conveyors. The washer/compactor shall be used to wash and compact screenings that have been captured by the screens. The screenings shall be pressed or compacted using a screw into a friction cylinder causing entrapped water to drain from the screenings while the screenings are conveyed through the cylinder and up a discharge pipe using hydraulic or mechanical pressure. Washer-compactor to be equipped with 4-inch flanged drain. The washed and compacted screenings will be discharged into a chute that will ultimately lead to a screening and grit collection dumpster. The controller shall provide independent control of each washer-compactor, and must coordinate with the controls of the screw conveyors and screens.

- B. A Local Control Panel shall be furnished to provide the required equipment operating and shutdown sequence. The Local Control Panel shall be furnished in the Screen Room adjacent to the equipment. The control panel enclosure, switches, and controls local to each unit shall be UL listed for operation in Class 1, Division 2 Hazardous atmosphere.
- C. The screens will run continuously, thus at least one washer compactor will be fed a continuous stream of screenings that will vary based on the volume and quantity of screenings that enter the plant.
- D. All wetted components shall be of Type 316L stainless steel construction or UHMW plastic.
- E. The selected manufacturer shall very clearly during the bidding and later during shop drawing clearly identify on a separate page in the front of the shop drawings any deviations or exceptions taken to the specification. If no such documentation is provided, the Engineer will assume that the manufacturer meets all requirements of this specification and will abide by all requirements specified herein. All exceptions or deviations taken by the equipment manufacturer other than the named herein will be reviewed by the Engineer and in consultation with the Owner may decide to reject if unacceptable in which case the Contractor will be required to provide suitable equipment from the named manufacturers. Due to the differences between the arrangement of the equipment manufactured by the named manufacturers, the Contractor shall pay specific attention to the "Approved shop drawing" of the screening and conveyance equipment and the following washer compactor during construction to avoid any major errors. All such errors that occur shall be responsibility of the Contractor and Contractor shall fix the errors at the Contractor's own expense.
- F. Should equipment which differs from this Section be offered and determined to be the equal of that specified, such equipment shall be acceptable only on the basis that all revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc, required to accommodate such a substitution shall be made at no additional cost to the Owner and be as approved by the Engineer.
  - 1. The supplier shall provide a three-year service contract. The supplier will provide as part of this service contract a certified service tech to visit the site every six months for the three year period. The service tech will check the washer compactor for proper operation, wear, make adjustments as needed and perform training for staff. Visit to be scheduled with the Owner at least two weeks prior.

## 2.2 WASHER COMPACTOR

- A. The washer compactor shall be completely factory assembled to assure proper fitting of parts. Disassembly in preparation for shipment shall be minimized to the extent possible.
- B. The washer compactor unit shall consist of the following components:
  - 1. Washing chamber, Preliminary Compaction Zone, and Main Compaction Zone.
    - a. Or Engineer Approved equal
  - 2. Drive unit.
  - 3. Discharge conveyance pipe.

4. Spray Wash System.
  5. Controls.
- C. The screenings shall fall from the wastewater fine screen by gravity into one of two shaftless screw conveyors. Each shaftless screw conveyor shall have the ability to convey screenings to either washer/compactor. The washer/compactor shall use its equivalent washing and compaction zone to remove fecal matter, dewater screenings and compact the volume of the screenings. Following compaction, the screenings shall be conveyed to the discharge conveyance pipe. The discharge conveyance pipe shall transport the washed and compacted screenings plug vertically and horizontally to the degree of being able to be discharged to the discharge chute as shown on the Drawings. Water expelled from the screenings by the wash and press unit shall drain through conical drainage holes or machined openings in the bottom of the press chamber. Discharge water shall be returned to the influent channel with the organics. The wash and press unit shall have a continuous screenings capacity of not less than 90 ft<sup>3</sup>/hr. The unit shall have a minimum batch capacity of 30 ft<sup>3</sup>/hr, if batch mode is applicable to the unit.
1. Each washer compactor will be located directly under both shaftless screw conveyors on the upper level of the Preliminary Treatment Building. Discharge water shall be routed back down to lower level of the Preliminary Treatment Building into the bar screens effluent channel.
  2. Each washer compactor shall be outfitted with caster wheels and quick disconnects so the Owner can easily disconnect the unit and slide it away from the mechanical screen for maintenance. All chutes, power and water connections shall be provided with connections that can be easily disconnected by the owner without requiring an electrician or plumber, and shall be appropriate for the Class 1 Div 2 area.
- D. The drive unit shall be a minimum of 5 HP and maximum of 7.5 HP, 460 Volt, 3 Phase, 60 Hz, TEFC Explosion Proof motor for Class 1 Div 2 service, having a maximum nominal speed of 1800 RPM.
- E. The unit shall be provided with not less than three connections for injecting wash water into the unit. The unit shall be designed to accept wash water from the facility's non-potable water system, which is sourced from final plant effluent. All unit components shall be designed such that the facility's final plant effluent will not clog any nozzles, orifices, or components of the unit. All orifices and nozzles shall be minimum 0.0625-inch (1/16<sup>th</sup> inch) diameter.
- F. The main wash water supply line to the wash and press unit shall be provided with a water solenoid valve with maximum operating pressure of 125 psig. This solenoid valve shall be slow close and suitable for Class 1 Div 2 service. The spray system piping will be minimum 1-inch diameter schedule 80 PVC.
- G. The washer compactor may be supported on legs and caster wheels that are field adjustable to allow 6-in of inclination of the press.
- H. Drained water from the press shall discharge to schedule 80 PVC piping routed back into the bar screens effluent channel.
- I. The unit's conveyance tube, press pipe, the screenings feed hopper, entire screw, and all flanges shall be of AISI Type 316L stainless steel.

- J. The washer compactor shall be Vulcan Model EWP 250, Duperon WC3, JWC Environmental MWP-0018, Spirac SW-Q215, or engineer approved equal.
- K. The screw conveyors and washer compactors shall be separate units connected via an external chute provided by the screw conveyor manufacturer (section 411213.36). The Washer-Compactor supplier will coordinate with the screw conveyor supplier through the Contractor accordingly.

## 2.3 CONTROLS

### A. Description:

- 1. The washer compactors can be started and stopped manually from the Local Control Panel or from PCS. The operator will also have the ability to run the washer compactor in jog reverse from the Local Control Panel to clear the unit of any blockages.
- 2. The washer compactors can be set to run automatically from the PCS in one of two modes: Batch or Continuous mode. If either screw conveyor is running, the auto-enabled washer compactor shall run until the conveyor has stopped. If the corresponding knife gate to active conveyor is not open, the compactor will not run.
- 3. In the event of a motor overload, the washer compactor motor starter can be reset from the Main Control Panel.
- 4. Refer to Control Logic per Section 406196 "Process Control Descriptions" for coordination with plant control system.

### B. Refer to the P&IDs for requirements for control panel layout requirements (i.e., lights, switches, indicators) and I/O signals to plant control system.

### C. The motor starters will be located in the Main Control Panels located in the Panel Room.

### D. Main Control Panels

- 1. Each washer-compactor shall be provided with a Main Control Panel in a NEMA 12 enclosure.
- 2. Each Main Control Panel shall contain the necessary control relays, timers, control power transformers, and other devices required for the correct operating sequence.
- 3. Pushbuttons and pilot lights shall be provided as shown on the Contract Drawings and as specified in Specification Section 262505 "Selective Demolition for Electrical."
- 4. Each Main Control Panel shall be suitable for use on a 480 Volt, 3-phase, 60 Hz power supply.
- 5. Main Control Panel shall be UL-listed and labeled.

### E. Local Control Panels.

- 1. Each Washer-compactor shall be provided with a Local Control Panel in a NEMA 7 enclosure.
- 2. Each Local Control Panel shall contain the necessary control relays, timers and other devices required for the correct operating sequence.
- 3. Pushbuttons, selector switches, and pilot lights shall be provided as shown on the Contract Drawings and as specified in Section 262505 "Selective Demolition for Electrical."
- 4. Local Control Panels shall be suitable Class I, Division 2 hazardous (classified) areas.



F. Controls.

1. Control Devices.

- a. Pilot devices shall be mounted on the enclosure front panel door.
- b. The Main Control Panel shall have indicator pilot lights for as shown on the Drawings.
- c. Lamps and the selector switches for the Local Control Panel shall be heavy duty NEMA 7 type.
- d. Lamps for the Main Control Panel shall be heavy duty NEMA 4X type.
- e. Controller transformer shall be protected by two primary fuses and one secondary fuse. The 120-volt secondary shall have one leg grounded.
- f. Relay contacts shall be included for signal outputs as indicated on the Drawings. The contacts shall be rated 10 ampere, 240 VAC, resistive load.
- g. Provide high motor temperature switch for each washer compactor as shown on the drawings. Instrumentation shall be suitable for Class I, Division 2 hazardous locations.

2. Motor Starters.

- a. Starters shall be a full-voltage reversing type with 120-volt operating coils.
- b. If applicable, forward and reverse contactors on the starters shall have both mechanical and electrical interlocks.
- c. Overload relays (OL) shall be adjustable so that the range selected includes the full load amperes (FLA) rating and service factor.

2.4 SHOP PRIMING

- A. Surface preparation and shop priming shall be part of the work of this Section and shall be as specified in Section 099100 "Painting."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be furnished by the equipment manufacturer and set in accordance with the manufacturer's recommendations and setting drawings.
- B. The Contractor shall be responsible for the coordination of this equipment with the requirements of the screenings chute leading to the container in the truck bay to obtain a complete, integrated and satisfactory operating installation.

### 3.2 INSPECTION AND TESTING

- A. The manufacturer shall furnish the services of a factory representative who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise a test run of the equipment. These services may not be combined with those provided under Part 1 Article "System Description" above.
- B. Prior to Start-up: Installation certificate from manufacturer's representative that equipment has been properly installed and is ready for start-up and functional testing.
- C. Working in coordination with the Owner and in the presence of the Engineer, the factory representative shall perform dry field tests on the washer compactor as follows:
  - 1. Each washer compactor shall have a four-hour continuous dry test run under conditions approximating actual operating conditions to demonstrate the correct alignment, smooth operation, freedom from vibration, excessive noise and overheating of the parts and bearings.
  - 2. The factory representative shall instruct plant personnel as to the operation and maintenance of the equipment including startup, shutdown and preventive maintenance.
  - 3. All defects recorded during the above field tests and all defects and failures occurring within the first year of operation shall be corrected at no cost to the Owner.
  - 4. The tests shall be conducted in the presence of the Engineer.
  - 5. In the event of improper installation or improper operation, all defects shall be corrected at no additional cost to the Owner, until the equipment operates to the satisfaction of the Engineer. If the mechanism remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory mechanism at the Contractor's expense.
- D. Upon satisfactory completion of the functional test, working in coordination with the Owner and in the presence of the Engineer, the factory representative shall perform performance field tests on the washer compactor as follows:
  - 1. Each washer compactor shall have a four-hour performance test where it shall operate in both batch and continuous mode as directed by the project officer with screenings from all available bar screens. During performance test, each washer compactor shall pass pine 2-inch x 4-inch x 12-inch and 5 gallon volume of flushable wipes in addition to screenings available from bar screens. Washer compactor shall operate without jams or alarms.
  - 2. Adjust, repair, or modify, as needed to ensure proper operation and performance.
  - 3. Shutdowns to replace components failing to perform as specified will require the acceptance test to be repeated.
  - 4. Make final adjustments to equipment under direction of manufacturer's representative.
- E. Acceptance Testing: Upon satisfactory completion of the performance testing.
  - 1. Acceptance period shall be seven days of continuous operation per washer compactor with minimum run time of 96 hours per washer compactor upon completion of performance testing. Manufacturer shall be available on-call and on-site within 24-hour notice, as needed during acceptance period.

END OF SECTION 462173.13

## SECTION 462544 - SCUM CONCENTRATOR SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes Scum Concentration system to receive a scum slurry from Arlington County's primary clarification system. The system shall concentrate, heat, and convey the concentrated scum to screening and grit collection bins for off-site hauling.
  - 1. Painting, except as specified herein, is included in Division 09.
  - 2. Instrumentation is included in Division 40.
  - 3. Piping, valves, pipe and equipment insulation and electric heat tracing are included in the respective sections of Division 40.
  - 4. Electrical wiring is included in Division 26.
- B. Related Requirements:
  - 1. Section 055000 "Metal Fabrications" for miscellaneous metalwork and fasteners as required by this Section.
  - 2. Section 099100 "Painting and Coating" for painting, coating, and touchups as required by this Section.
  - 3. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections to equipment specified in this Section.
  - 4. Section 262505.00 "480V Control Panels".
  - 5. Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment" for electric motors for conveyor drive units.
  - 6. Section 406100 "Process Control and Enterprise Management Systems."
  - 7. Section 406121 "Process Control System Testing."
  - 8. Section 406196 "Process Control Descriptions."
  - 9. Section 406733 "Panel Wiring."
  - 10. Section 407816 "Indicating Lights."
  - 11. Section 407819 "Switches and Pushbuttons."
  - 12. Section 407853 "Relays."
  - 13. Section 407243 "Pressure and Differential Pressure Type Level Meters"
  - 14. Section 407276 "Level Switches"
  - 15. Section 407313 "Pressure and Differential Pressure Gauges."
  - 16. Section 407336 "Pressure and Differential Pressure Switches."
  - 17. Section 407363 "Diaphragm Seals."
  - 18. Painting, except as specified herein, is included in Division 09.
  - 19. Instrumentation is included in Division 40.

20. Piping, valves, pipe and equipment insulation and electric heat tracing are included in the respective Sections of Division 40.
21. Electrical wiring is included in Division 26.
22. Section 262505.00, "480V Control Panels".

### 1.3 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation and field test the scum concentrator system as indicated on the Drawings. The system shall be furnished and installed complete as indicated on the Drawings and as specified herein.
- B. The scum concentrator system shall comprise a scum concentrator and concentrated scum storage and feed pump system as follows:
  1. Scum concentrator:
    - a. Scum slurry concentration tank.
    - b. Motor-driven chain and flight scum skimmer.
    - c. Tank drain piping and valve.
    - d. Access platform and ladder.
    - e. Flanged inlet and outlet pipe connections.
    - f. Concentrated scum chute to concentrated scum tank.
    - g. Removable odor containment covers.
  2. Concentrated scum storage and feed pump system:
    - a. Hot water jacketed concentrated scum tank.
    - b. Motor driven tank mixer.
    - c. Tank hot water heating system.
    - d. Concentrated scum pump and shelf spare.
  3. Packaged Main Control Panel for skimmer, heating system, concentrated scum storage tank mixer and concentrated scum pump with motor starters.
  4. Packaged skid-mounted Local Control Panel.
- C. Furnish all labor, materials, equipment and incidentals required and install local control panel and motor panel containing all necessary controls and communication equipment to monitor the system and communicate with the plant's PCS. Start-up and testing of controls with the Owner.

### 1.4 ACTION SUBMITTALS

- A. Submit the following:
  1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.
  2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Complete master wiring diagrams, elementary or control schematics, including coordination with other electrical control devices and suitable outline drawings shall be furnished for approval before proceeding with manufacture.
    - a. Provide suitable outline drawings showing such details as are necessary to locate conduit stub-ups and field wiring.
    - b. Due to the complexity of the system, it is imperative the above drawings be clear and carefully prepared to facilitate interconnections with other equipment. Standard pre-printed sheets or drawings simply marked to indicate applicability to the Work are not acceptable.
  4. A complete total bill of materials of all equipment.
  5. A list of the Manufacturer's recommended spare parts to be supplied in addition to those specified in Part 1 Article "Maintenance," with the manufacturer's current price for each item.
    - a. Include gaskets, packing, etc. on the list.
    - b. List bearings by the bearing manufacturer's numbers only.
  6. Complete motor, drive, and performance factor data in accordance with Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment".
  7. Details of the control panel, relays, wiring diagram, dimensions, weights, and additional requirements in accordance with Section 262505.00 "480V Control Panels".
  8. Equipment instrumentation and control description and instrumentation installation details.
  9. A memory map to the OWNER no later than 30 days prior to the scheduled shipment of the vendor equipment to the site.
- B. Main Control Panel and Local Control Panel Drawings: Drawings shall be furnished for all panels, consoles, and equipment enclosures specified in this Section. The drawings shall be drawn to scale and detail all equipment in or on the panel. As a minimum, the panel drawings shall include the following:
1. Equipment mounted on the panel.
  2. Nameplate schedule detailing every line on each nameplate.
  3. Conduit access locations.
  4. Panel construction details.
  5. Manufacturer's model number.
  6. Interior and exterior panel elevation drawings to scale.
  7. Cabinet assembly to scale and layout drawings to scale.
    - a. Include a bill of material on the drawing with each panel component clearly defined. cross-reference to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
  8. Fabrication and painting specifications including color (or color samples).
  9. Panel wiring diagrams showing all power and control connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes, and grounding.

- a. wiring diagram in ladder logic format and shall reference the appropriate loop drawing for continuations or details where required.
  - b. Show all wire numbers, wire sizes, wire colors, terminal block numbers, and equipment or device terminal block numbers.
- C. Draft and Final Operations and Maintenance Manual to the Owner in accordance with Section 017823 "Operation and Maintenance Data." The instructions shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, and descriptions necessary to instruct operating and maintenance personnel unfamiliar with such equipment. Installation drawings, wiring diagrams, and maintenance requirements shall all be included. Furnish for review by the Owner a draft version of the O&M Manual. Respond to Owner comments and furnish four final hard copies and two final electronic copies of final O&M Manual. Hard copies to be provided to the Owner in 3-ring binders.
- D. In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe completely all non-conforming aspects.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Test Reports to be Submitted:
1. Description of test procedures and equipment.
  2. Copies of all test results, as specified in Parts 2 and 3 of this Section.
- B. Manufacturer's Certificate of Installation, Testing and Instruction as specified in Division 01.

#### 1.6 MATERIAL MAINTENANCE SUBMITTALS

- A. Spare Parts
1. The following spare parts shall be provided with the scum concentrator:
    - a. Concentrator system:
      - 1) One set of bearing assemblies for skimmer
      - 2) One set of skimmer chain sprockets
      - 3) One set of skimmer drive chains
      - 4) One set of replacement neoprene wiper blades
    - b. Concentrated scum system:
      - 1) One complete replacement concentrated scum pump and drive unit
      - 2) One concentrated scum pump stator
      - 3) One set of packing for concentrated scum pump
    - c. Scum Concentrator Control Panel spare parts in accordance with Section 262505 "480V Control Panels".
- B. Special Tools

1. Furnish one set of all special tools required for normal operation and maintenance of the equipment.

#### 1.7 CLOSE OUT SUBMITTALS

- A. Complete operating and maintenance instructions for all equipment specified herein accordance with the General Conditions and Section 017823 "Operation and Maintenance Data."

#### 1.8 QUALITY ASSURANCE

##### A. Qualifications

1. All the equipment specified under this Section shall be furnished by a single manufacturer and shall be standard units of proven ability as manufactured by a competent organization that is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.
2. All equipment furnished under this Section shall be new and unused and shall be the standard products of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein.
3. These Specifications are intended to give a general description of what is required but do not cover all details which may vary in accordance with the exact requirements of the equipment as offered. They are, however, intended to cover the furnishing, delivery, installation, field testing and field calibration of all materials and apparatus as required. Any additional equipment necessary for the proper operation of the proposed installation not specifically mentioned in these Specifications or indicated on the Drawings shall be furnished and installed at no change in Contract Price or Time.
4. Qualified manufacturers are EnviroCare, Walker Process Equipment, RDP or Engineer Approved Equal.

##### B. Services of the Manufacturer's Representative

1. The equipment manufacturer shall furnish the services of a competent and experienced factory representative who has complete knowledge of proper installation, operation and maintenance of the equipment to inspect the installed equipment, provide vendor training to plant personnel in operation and maintenance of the equipment, perform an initial test run and conduct final performance testing.
  - a. One 8-hour day (excluding travel time) for checking and inspecting the equipment after it is installed.
  - b. Four 4-hour training sessions delivered on different dates, per coordination with the Owner. Each training sessions shall be 2-hours classroom and 2-hours field. This instruction period shall be scheduled at least ten days in advance with the OWNER and shall take place prior to plant start-up and acceptance by the OWNER. The final approved copies of operation and maintenance manuals must have been delivered to the ENGINEER prior to scheduling the instruction period with the OWNER.

- c. Minimum two 8-hour days (excluding travel time) to conduct functional testing of the system with water and to perform the initial test run on process fluid and conduct final performance testing.
  - d. Upon completion of the final performance testing, the Owner shall conduct a 30-day acceptance test where the manufacturer representative shall be available on-call and able to come on-site within 24 hours per the Owner's request.
2. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or contractor's installation, additional service shall be provided at no change in Contract Price or Time.
  3. Manufacturer representative to be on-site for coordination and programming support with Owner Staff. Provide three 8-hour days on-site.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be crated and delivered to protect against damage during shipment.
- B. Equipment shall be protected against damage during storage at the site.
- C. The finished surfaces of exposed flanges shall be protected by wooden blank flanges securely bolted thereto.

#### 1.10 WARRANTY

- A. All equipment supplied under this Section shall be warranted for a period of two (2) years by the CONTRACTOR and the Manufacturer. Warranty period shall commence as outlined in the General Conditions and Section 017700 "Closeout Procedures."
- B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s) and the unit(s) restored to service at no expense to the OWNER.
- C. The Manufacturer's warranty period shall run concurrently with the CONTRACTOR's warranty period. No exception to this provision shall be allowed.
- D. Refer to the General Conditions and Division 01 for additional warranty requirements.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. The Preliminary Treatment Building Screen Room is a Class I, Division 2, hazardous location per NFPA 820. All electrical equipment, conduit, wiring, installation, etc., within the classified area shall be suitable for Class I, Division 2 locations. The dimensions of the entire scum concentration system shall not exceed the footprint indicated on the drawings.



- B. All rotating parts and potential pinch points shall have guards. Equipment requiring guards shall include, but not be limited to, pump and mixer drive shafts, skimmer drive, chains, and motors. Guards shall comply with OSHA standards.

## 2.2 SCUM CONCENTRATOR TANK AND SKIMMING MECHANISM

- A. The concentrator tank shall receive dilute primary scum slurry from the existing scum pumping system. The scum slurry shall pass through a grinder prior to entering the Scum Concentration system. The floating material (concentrated scum) shall be skimmed from the water surface by a chain and flight motor-driven collector. The skimmed material shall be discharged through a stainless steel chute into the concentrated scum tank adjacent to the concentrator tank, and the effluent shall discharge to a gravity drain. The minimum dilute primary scum slurry capacity shall be 100 gpm.
- B. Scum concentrator tank shall have two 4-inch flanged inlet connections, one 4-inch flanged drain connection, one 6-inch flanged drain connection, and one 6-inch flanged overflow connection as indicated on the drawings.
- C. The concentrator tank shall be rectangular, fabricated from 1/4-inch Type 316 stainless steel plate with stiffeners and legs as appropriate to prevent excessive distortion and stress due to loads imposed during shipping, installation and operation. The tank shall be watertight, welded construction. Tank volume should be appropriate for a 30-minute retention time or 2.5 gpm/sq ft separation rate at 100 gpm scum slurry flows. Concentrated scum shall have a minimum total solids of 30%.
- D. The tank design shall include lifting lugs, an inlet flow distributor, decant compartment, scum and underflow baffle, mechanically adjustable level control assembly, skimming beach ramp and a full surface area skimming mechanism. Provide high-high level float switch for concentrator tank mounted above the water surface elevation of the overflow.
- E. The skimming mechanism shall consist of a gear-motor drive with an adjustable torque limiting device, driving a single roller chain, which in turn drives a Type 316 stainless steel shaft and polymeric sprockets carrying two strands of polymeric pintle chain, carrying stainless steel flights with neoprene wiper blades on maximum 32-inch centers. The chains shall be supported by polymeric sprockets on Type 316 stainless steel shafts, which ride in ball bearing take-ups. The flight speed shall be constant at approximately 9 feet per minute. Take-ups shall have a minimum of 4 inches of adjustment. Drives and chains shall be furnished with guards. Drive shall be a SEW-Eurodrive or engineer approved equal. The electric motor and drive system shall be explosion proof, designed for operation in Class 1, Division 2, Group D hazardous areas. Motors shall meet the requirements of Section 400593.23. Provide motor temperature switch. Provide high motor temperature switch as indicated on the drawings. Instrumentation shall be suitable for Class I, Division 2 hazardous locations.
- F. The overflow trough shall be fabricated from steel plate and integral to the concentrator tank. Effluent connection shall be 6-inch flanged. An adjustable, gasketed weir plate shall be provided across the full width of the tank. The weir plate shall have a minimum 2-1/2" elevation adjustment. Vertical adjustment of the weir plate shall be by means of a mechanical crank that is accessible from the platform.

- G. The beach plate shall be integral to the concentrator tank. Adjustable brackets shall be provided for alignment of the skimmer flight as it travels up the beach in order to ensure a clean sweep.
- H. The support structure shall be fabricated from Type 316 stainless steel structural members. Support legs shall have 8-inch square flat base plates, which shall bear on concrete bases. They shall have shims or grout inserted on the bases so that all supports shall carry the operating weight without distortion.
- I. Drive motor shall comply with Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment."

## 2.3 SERVICE PLATFORM AND ACCESS LADDER

- A. The concentrator shall be fitted with a service platform along three sides of the concentrator with access ships ladder as indicated on the Drawings. Service platform and access ships ladder shall be minimum 2 feet, 6 inch wide and fabricated from stainless steel. Contractor to confirm proposed platform width fits within existing space without impact to existing or new piping and systems. FRP may be provided as an option. The service platform shall meet the servicing access requirements of the concentrator system. The platform deck grating, guard rail, and access ladder shall meet OSHA standards and details on the Drawings. Access ladder shall be 70 Degree Ships Ladder Mezzanine Access type with handrail. Clips and bolts shall be stainless steel.

## 2.4 ODOR CONTAINMENT COVERS

- A. The concentrator tank shall be covered with hinged Type 316 stainless steel FRP gasketed covers with handles and latches to fully enclose concentrator for odor control purposes. The covers shall have minimum thickness of ¼-inch for FRP. The covers shall be manufactured sections easily lifted for inspection. The scum concentrator shall operate normally with the covers in place.
- B. A 10-inch flanged odor removal pipe connection with a blind flange shall be located on the Concentrator Tank covers as indicated on the Drawings. A 6-inch flanged odor removal pipe connection with a blind flange shall be located on the Concentrated Scum Storage Tank cover.

## 2.5 CONCENTRATED SCUM CHUTE

- A. The scum concentrator system supplier shall furnish a rectangular concentrated scum chute to convey concentrated scum from the concentrator to the concentrated scum tank, located adjacent to the concentrator. The chute shall be fabricated from minimum 14-gauge Type 316 stainless steel.
- B. The chute shall be flanged at the connection to the concentrator tank and shall be slip fit through the top cover of the concentrated scum tank. The opening shall be field sealed by the CONTRACTOR after installation with sealing materials as recommended by the scum concentrator manufacturer.

- C. The circular part of the chute shall not be fabricated until the scum concentrator and concentrated scum storage tank have been installed so that the chute may be accurately fabricated. The chute shall be supported from the scum concentrator.

## 2.6 CONCENTRATED SCUM STORAGE AND FEED PUMP SYSTEM

- A. The concentrated scum tank shall be circular in plan and shall have a minimum capacity from flange bottom to high operating level of 500 gallons. The tank bottom flange shall be connected to the feed pump inlet flange through a minimum 8-inch stainless steel wafer type knife gate valve with limit switches. The tank shall be provided with the following:
  - 1. A Type 316 stainless steel water jacket designed for a maximum operating hot water temperature of 210-degree-F, maximum operating pressure of 30 psig and maximum pressure drop of 10 psi. Provide 2" NPT connections for inlet and outlet hot water piping.
  - 2. Provide hot water heater skid consisting of hot water circulation heater, hot water circulation pump and heater surge tank in a closed loop County Owned Water system as indicated on the drawings. Skid dimensions shall be limited to 18 inches wide by 102 inches long by 32 inches high.
    - a. Hot water circulation heater shall be sized to heat concentrated scum in concentrated scum storage tank to 85 to 140 degrees Fahrenheit. Heater vessel shall have 2-inch NPT inlet and outlet connections with 3/4-inch NPT vessel drain. Heater shall be 60 kW, 480 V, 3-phase and rated for Class I, Division 2 hazardous areas. Provide temperature instrument and pressure transmitter for loop water temperature and pressure and temperature switch for heater element overtemperature protection as indicated on the drawings. Contractor shall allow a minimum of 88" for heating element insertion and removal. Heater shall be Chromalox Model NWH-06-060P-E2XX for clean water applications, or equal.
    - b. Hot water circulation pump shall be rated for 15 gpm at 29 feet TDH. Pump motor shall be rated for Class I, Division 2 hazardous areas. Pump shall be Bell & Gossett, or equal.
    - c. Heater thermal expansion tank shall be Amtrol, Inc., Model No. ST-5 thermal expansion tank, or equal. Provide vent with pressure relief valve on thermal expansion tank.
    - d. Provide high motor temperature switch for hot water circulation heater and pump as indicated on the drawings. Instrumentation shall be suitable for Class I, Division 2 hazardous locations.
  - 3. Rigid insulation with aluminum sheathing, minimum R-13.
  - 4. Hinged or lift-off FRP or stainless-steel gasketed cover with high-high level float switch and temperature instrumentation as indicated on the drawings. Provide 1.5inch flanged connection on cover of concentrated scum tank for recirculation flows from the concentrated scum pump. Connection shall be above water line via stainless steel union coupling. Connection shall extend 6" below the water line inside of the tank.
  - 5. System shall not be degraded by exposure to the scum solids, mixing, or high temperature.
  - 6. A top mounted mixer to maintain the concentrated scum in a homogenous state during heating and pumping.
  - 7. An outlet Type 316 stainless steel wafer-type flanged knife gate valve, minimum 8-inch diameter, with limit switches.

8. A 3-inch flanged connection for overflow as indicated on the drawings.
- B. Concentrated scum piping from the discharge of the concentrated scum pump to screening and grit collection bins shall be by the CONTRACTOR. Piping and fittings shall be Type 316 stainless steel in accordance with Section 400523 "Stainless Steel Process Pipe and Tubing for Ozone Service." Valves shall be per Section 400551 "Process Valves."
- C. The CONTRACTOR shall provide heat tape and thermostatic controls and insulation and sheathing for the concentrated scum piping to the screening and grit collection bins, as indicated on the drawings. The heat tapes for the concentrated scum pump discharge piping and delivery point shall maintain a minimum temperature of 110-degree F but not greater than 140-degree F maximum when energized. Insulation and heat tracing shall conform to Sections 404213 "Process Piping Insulation," and 404113.13 "Process Piping Electrical Resistance Heat Tracing," respectively. Heat tracing shall be suitable for Class I, Division 2 hazardous locations.
- D. Concentrated Scum Pump
1. The concentrated scum pump shall be capable of pumping concentrated scum from the concentrated scum hopper to one haul bin at a time or recirculate concentrated scum back into the concentrated scum hopper.
  2. The concentrated scum feed pump shall be a progressing cavity pump with a duty point of 10 gpm at 125 psi total head. The pump shall be constant speed. Maximum pump speed shall be 1800 rpm. Pump shall pass 0.5-inch solids. Pump shall be four-stage and shall have an open throat with auger feed.
  3. Stator and other materials shall be suitable for heated scum with possible occasional petroleum products. Pump shall be Moyno 2000 Series G2 or equal. Shaft seal shall be packing type. Provide a seal leakage drain pipe.
  4. The pump shall be floor mounted and shall not be supported from the concentrated scum tank.
  5. Provide a suitable fabricated 316 stainless steel adapter between the open throat pump with auger feed and knife gate valve. Pump shall be driven by a C-face motor and gear box rigidly supported by the pump and connected with a flexible coupling. Provide a coupling guard in accordance with OSHA requirements. Provide flushing connection, low-low level frequency shift tuning fork switch, and differential pressure-based level instrument on adapter as indicated on the drawings.
  6. The electric motor and drive system shall be explosion proof, designed for operation in Class 1, Division 2 hazardous areas. Motors shall meet the requirements of Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment."
  7. Provide high motor temperature switch, stator temperature switch and discharge pressure gauge with high pressure switch as indicated on the drawings. Instrumentation shall be suitable for Class I, Division 2 hazardous locations.
  8. Provide a complete spare concentrated scum pump and drive unit per Part 1 "Maintenance."
- E. Concentrated Scum Mixer
1. The concentrated scum mixer shall promote uniform heating of the concentrated scum. The mixer shall include a drive motor, gear reducer assembly, support structure, couplings and guards, shafting and impeller assembly.

2. Mixer configuration and selection shall be by the equipment supplier. Mixer shaft and impellers shall be stainless steel. Provide impellers with split clamp-on hubs or set screw mounting.
3. The mixer shall be mounted vertically above the concentrated scum tank and shall be driven by a C-face motor with integral gear box. The electric motor and drive system shall be explosion proof, designed for operation in Class 1, Division 2 hazardous areas. Motors shall meet the requirements of Section 400593.23 "Low-Voltage Motor Requirements for Process Equipment."
4. Mixer shall have a disassembly coupling or flange located above the tank cover between the gear box and mixer shaft. The disassembly flange shall facilitate removal of the mixer shaft and impellers without removing the motor and gear box from the tank.
5. Provide high motor temperature switch as indicated on the drawings. Instrumentation shall be suitable for Class I, Division 2 hazardous locations.

## 2.7 CONTROL SYSTEMS

### A. Description:

1. The Scum Concentrator System shall collect and discharge scum to the East and West screening bins. The Skimmer/Collector will be called to run when the Scum Slurry Pumps are discharging into the Scum Concentrator Tank. If the high-high level switch in the Scum Skimmer Concentrator Tank is tripped, the pump discharge will be diverted away from the Scum Skimmer Tank. Scum will be skimmed into the Scum Hopper equipped with a Mixer and hot water jacket to keep the scum liquefied. A Hot Water Pump and Heater will provide the hot water jacket with hot water based on the temperature in the Hopper. The Mixer and Scum Pump will run based on operator level and temperature setpoints measured by differential pressure level sensor, high-high level float switch, low-low level frequency shift tuning fork, and temperature sensor. The scum pump will be able to operate in one of two modes automatically: Feed Mode or Feed and Recirc Mode. In Feed Mode all scum will be discharged to the screenings and grit bins. In Feed and Recirc mode, two motorized valves will divert scum to between the screenings and grit bins and the hopper based on the level in the tank.
2. After restoration of power after a power supply failure, all associated scum concentration system equipment controlled at the PCS in automatic mode will return to automatic functions.
3. Refer to Control Logic per Section 406196 "Process Control Descriptions" for coordination with plant control system.

### B. One common Scum System Main Control Panel shall be provided and shall house the motor starters for all equipment associated with the Scum System. The Main Control Panel shall be located in the Panel Room in a NEMA 12 steel enclosure.

1. Refer to the P&IDs for requirements for control panel layout requirements (i.e., lights, switches, indicators) and I/O signals to plant control system.
2. Main Control Panel components shall meet the requirements of Specification Section 262505.00 "480V Control Panels".
3. The Main Control Panel shall house the control power transformer for control power and all starters, contactors, timers, switches, relays, alarms, indicating lights, and operator

controls for operation of the system. Motor overload shall immediately shut down the skimmer motor and activate an alarm.

- C. One common Scum System Local Control Panel shall be provided with local controls for the Scum Skimmer/Collector, Scum Hopper Mixer, Concentrated Scum Pump, and Hot Water Heating System:
  - 1. Local Control Panel construction, devices, and wiring shall comply with the control panel construction requirements of Section 262505 “480V Control Panels.” Instrumentation shall comply with the requirements of Sections 407000 “Instrumentation for Process Systems” and shall be suitable for Class I, Division 2 hazardous locations.
  - 2. Panel enclosure shall be skid-mounted of NEMA 7 suitable for a Class I, Division 2, Group D hazardous location. Panel shall have front access and shall be amply sized to suit the equipment furnished without crowding.
    - a. Wiring shall be completed in accordance with Divisions 26 and 40. Wiring shall comply with the latest edition of the National Electrical Code.
    - b. Refer to the P&IDs for requirements for control panel layout requirements (i.e., lights, switches, indicators) and I/O signals to plant control system.

## 2.8 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standard: Fabricate and label system components to comply with NFPA and other applicable local and state standards.

## 2.9 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 400593.23 “Low-Voltage Motor Requirements for Process Equipment”.
  - 1. Enclosure: Explosion proof.
  - 2. Enclosure Materials: Cast iron.
  - 3. Motor Bearings: Sealed.
  - 4. Unusual Service Conditions:
    - a. Ambient Temperature: 75 degrees Fahrenheit.
    - b. Altitude: 30 feet above sea level.
    - c. High humidity.
  - 5. Efficiency: Premium efficient.
  - 6. NEMA Design: Class I Division 2.
  - 7. Service Factor: 1.15.
  - 8. Electrical Characteristics:
    - a. Scum Skimmer Motor

- 1) Horsepower: 0.5 HP.
- 2) Volts: 460.
- 3) Phase: 3.
- 4) Hertz: 60.

b. Concentrated Scum Mixer

- 1) Horsepower: 3 HP.
- 2) Volts: 460.
- 3) Phase: 3.
- 4) Hertz: 60.

c. Hot Water Circulation Pump

- 1) Horsepower: 0.75 HP.
- 2) Volts: 460.
- 3) Phase: 3.
- 4) Hertz: 60.

d. Concentrated Scum Pump

- 1) Horsepower: 5 HP.
- 2) Volts: 460.
- 3) Phase: 3.
- 4) Hertz: 60.

## 2.10 FABRICATION

- A. Shop Assembly: All welding of stainless steel shall be done at the factory and properly pickled and passivated. Welding of stainless steel will not be permitted on-site.

## 2.11 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Finish products after assembly.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations, and the approved shop drawings, in the locations indicated on the Drawings.

- B. Installation shall include furnishing the required grease and/or oil for initial operation. The grades of grease and/or oil lubricants shall be in accordance with the manufacturer's recommendations.

### 3.2 INSPECTION AND TESTING

- A. Furnish the services of a factory representative, who has complete knowledge of proper operation and maintenance to inspect and adjust the installed equipment prior to operation of the units and to final inspect the final installation and supervise a test run of the equipment.
- B. After the scum concentrator and the associated systems are installed and piping is completed and ready for operation, conduct in the presence of the Project Officer and under the supervision of the manufacturer's factory representative, a six-hour functional test run using water to demonstrate the unit's ability to operate as specified, without noise, vibration or overheating. Any deficiencies noted during the testing shall be corrected at no additional expense to the OWNER.
- C. When scum becomes available, performance test shall be made in the presence of the Project Officer under regular operating conditions, to further demonstrate that the scum concentrator performance conforms to this Section. It shall also be demonstrated that the scum concentrator control system repeatedly performs as specified. Scum Concentration system shall produce concentrated scum with a minimum total solids of 30% and minimum capture efficiency of 90%. Performance test shall be minimum six hours long, after steady state is achieved in the unit, and utilize grab samples every hour from the inlet, discharge, and overflow. The average of the grab samples must meet the minimum performance requirements above. Capture efficiency to be calculated per the following formula.

$$\text{Percent Capture} = \frac{C}{F} \times \frac{F - E}{C - E} \times 100$$

Where:

*C* = Concentrated Scum (% solids by weight)

*F* = Scum Slurry (% solids by weight)

*E* = Scum Concentrator Overflow (% solids by weight; measured as  $\frac{mg}{L}$  TSS/10,000)

- D. The scum concentrator will not be accepted until the scum concentrator passes a 30 day acceptance test under normal operating conditions with scum. If the scum concentrator shuts down due to an alarm or fault condition more than three times during the 30 day acceptance test, the scum concentrator will be considered unacceptable. The CONTRACTOR shall be permitted to modify the equipment completely at no expense to OWNER and the tests repeated, as described above.
- E. In the event of improper installation or improper operation, all defects shall be corrected at no expense to the OWNER, until the equipment operates to the satisfaction of the Project Officer.
- F. Comply with requirements for pipe hangers and supports specified in Section 400507.00 "Hangers and Supports for Process Piping."



- G. Comply with NECA 1.
- H. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- J. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the manufacturer standard tests and inspections with the assistance of a factory-authorized service representative:
- C. Prepare test and inspection reports.

### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.5 ADJUSTING

- A. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.
- B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.6 PROTECTION

- A. Remove and replace all materials that are wet, moisture damaged, or mold damaged.

### 3.7 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include six months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Provide four 4-hour sessions on different dates, per coordination with Owner, of classroom and hands-on instruction which will cover the theory of operation, actual operation of the scum concentration system, optimization of the operation, electrical maintenance, instrumentation maintenance and mechanical maintenance shall be included. Manufacturer shall allow Owner to video tape any and all training at the Owner's discretion. Training by local sales representative is unacceptable.

END OF SECTION 462544



