CONTRACT DOCUMENTS FOR THE CONSTRUCTION OF THE

# CITY OF MARCO ISLAND

# SOURCE WATER FACILITY BIOLOGICALLY ACTIVE FILTER IMPROVEMENTS



VOLUME 1 OF 2 SPECIFICATIONS

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**Jacobs** 

Project No. D3418006

JULY 2023

100% DOCUMENTS

## **CITY OF MARCO ISLAND**

## BIDDING REQUIREMENTS AND CONTRACT DOCUMENTS

for the construction of the

## SOURCE WATER FACILITY BIOLOGICALLY ACTIVE FILTER IMPROVEMENTS

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JACOBS

### **JULY 2023**

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Project No. D3418006

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## **END OF SECTION**

# TECHNICAL SPECIFICATIONS

## SECTION 01 11 00 SUMMARY OF WORK

## PART 1 GENERAL

## 1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. The completed Work will provide Owner with two fully equipped and completely functional biologically active filtration (BAF) horizontal pressure filters that will function as pre-treatment for membranes, including one backwash supply pump, one backwash air scour blower and one lake transfer pump. The completed Work will also provide Owner with new electrical equipment to support the increased electrical load. The Work will include the demolition and replacement of the existing lake transfer discharge pipe, which will be used as a BAF filters bypass header. The Work includes all associated demolition work, piping, electrical, geotechnical, instrumentation and controls, architectural, structural and civil site works within the limits of the Contractor work.
- B. Scope of contract work:
  - 1. Demolish an existing lake transfer pump, including associated equipment, pipes, valves and other pump appurtenances.
  - 2. Lake transfer pump: design, fabricate, transfer to Site, and install one lake transfer pump with all accessories, appurtenances and piping, associated motor, and instrumentation and controls.
  - 3. BAF filters: design, fabricate, transfer to Site, and install two biologically active horizontal pressure filters with all media, internal piping and underdrain systems, accessories, appurtenances and piping, and instrumentation and controls.
  - 4. Backwash supply pump: design, fabricate, transfer to Site, and install one backwash supply pump with all accessories, appurtenances and piping, associated motor, and instrumentation and controls.
  - 5. Air scour blower: design, fabricate, transfer to Site, and install one backwash air scour blower with all accessories, appurtenances and piping, associated motor and enclosure, and instrumentation and controls.
  - 6. Control panels: design, fabricate, transfer to Site and install control and remote I/O panels for the BAF filters, lake transfer pump, backwash supply pump, and air scour blower.
  - 7. Hardware: provide all hardware to connect the control and remote I/O panels to the existing multimode fiber optic ring network.

- 8. Software: provide all software development and programming for the lake transfer pump, BAF filters, backwash supply pump, and air scour blower Control Panel. SCADA integration will be done by the automation solutions provider (ASP), as detailed in Division 40, Process Interconnections specifications.
- 9. Demolish a portion of the existing lake transfer pump station effluent header, as shown in the Drawings, including associated pipes and connections. This piping, including associated connections, will be replaced with a new HDPE pipe to serve as a bypass to the BAF filters, as shown in the Drawings.
- 10. Provide all associated electrical, instrumentation and controls, civil and geotechnical works for a completely functional system.
- 11. Construct the work per suggested construction sequence and constraints in Section 01 31 13, Project Coordination.
- 12. Provide Type 316 stainless steel for all metal surfaces, including but not limited to pipe supports, control panels, panel supports, and enclosures. The general requirement is that all metal surfaces shall be corrosion-resistant without the use of coatings and paint. This requirement takes precedence over other documents, except for electrical conduits, which will be specified in Division 26, Electrical sections. Any discrepancies and inconsistencies shall be brought to the attention of the Owner, and failure to do so shall not result in additional cost to the Owner.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 GENERAL

A. The Contractor shall install equipment and provide all other Work for a completely operational system.

# **END OF SECTION**

## SECTION 01 26 00 CONTRACT MODIFICATION PROCEDURES

## PART 1 GENERAL

## 1.01 PROPOSAL REQUESTS

- A. Owner may, in anticipation of ordering an addition, deletion, or revision to the Work, request Contractor to prepare a detailed proposal of cost and times to perform contemplated change.
- B. Proposal request will include reference number for tracking purposes and detailed description of and reason for proposed change, and such additional information as appropriate and as may be required for Contractor to accurately estimate cost and time impact on Project.
- C. Proposal request is for information only; Contractor is neither authorized to execute proposed change nor to stop Work in progress as result of such request.
- Contractor's written proposal shall be transmitted to Engineer promptly, but not later than 14 days after Contractor's receipt of Owner's written request.
   Proposal shall remain firm for a maximum period of 45 days after receipt by Engineer.
- E. Owner's request for proposal or Contractor's failure to submit such proposal within the required time period will not justify a Claim for an adjustment in Contract Price or Contract Times (or Milestones).

### 1.02 CLAIMS

- A. Include, at a minimum:
  - 1. Specific references including (i) Drawing numbers, (ii) Specification section and article/paragraph number, and (iii) Submittal type, Submittal number, date reviewed, Engineer's comment, as applicable, with appropriate attachments.
  - 2. Stipulated facts and pertinent documents, including photographs and statements.
  - 3. Interpretations relied upon.
  - 4. Description of (i) nature and extent of Claim, (ii) who or what caused the situation, (iii) impact to the Work and work of others, and (iv) discussion of claimant's justification for requesting a change to price or times or both.

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- 5. Estimated adjustment in price claimant believes it is entitled to with full documentation and justification.
- 6. Requested Change in Contract Times: Include at least (i) Progress Schedule documentation showing logic diagram for request,
  (ii) documentation that float times available for Work have been used, and (iii) revised activity logic with durations including sub-network logic revisions, duration changes, and other interrelated schedule impacts, as appropriate.
- 7. Documentation as may be necessary as set forth below for Work Change Directive, and as Engineer may otherwise require.

## 1.03 WORK CHANGE DIRECTIVES

- A. Procedures:
  - 1. Engineer will:
    - a. Initiate, including a description of the Work involved and any attachments.
    - b. Affix signature, demonstrating Engineer's recommendation.
    - c. Transmit five copies to Owner for authorization.
  - 2. Owner will:
    - a. Affix signature, demonstrating approval of the changes involved.
    - b. Return four copies to Engineer, who will retain one copy, send one copy to the Resident Project Representative or other field representative, and forward two copies to Contractor.
  - Upon completion of Work covered by the Work Change Directive or when final Contract Times and Contract Price are determined, Contractor shall submit documentation for inclusion in a Change Order.
  - 4. Contractor's documentation shall include but not be limited to:
    - a. Appropriately detailed records of Work performed to enable determination of value of the Work.
    - b. Full information required to substantiate resulting change in Contract Times and Contract Price for Work. On request of Engineer, provide additional data necessary to support documentation.
    - c. Support data for Work performed on a unit price or Cost of the Work basis with additional information such as:
      - 1) Dates Work was performed, and by whom.
      - 2) Time records, wage rates paid, and equipment rental rates.
      - 3) Invoices and receipts for materials, equipment, and subcontracts, all similarly documented.
- B. Effective Date of Work Change Directive: Date of signature by Owner, unless otherwise indicated thereon.

## 1.04 CHANGE ORDERS

## A. Procedure:

- 1. Engineer will prepare six copies of proposed Change Order and transmit such with Engineer's written recommendation and request to Contractor for signature.
- 2. Contractor shall, upon receipt, either: (i) promptly sign copies, retaining one for its file, and return remaining five copies to Engineer for Owner's signature, or (ii) return unsigned five copies with written justification for not executing Change Order.
- 3. Engineer will, upon receipt of Contractor signed copies, promptly forward Engineer's written recommendation and partially executed five copies for Owner's signature, or if Contractor fails to execute the Change Order, Engineer will promptly so notify Owner and transmit Contractor's justification to Owner.
- 4. Upon receipt of Contractor-executed Change Order, Owner will promptly either:
  - a. Execute Change Order, retaining one copy for its file and returning four copies to Engineer; or
  - b. Return to Engineer unsigned copies with written justification for not executing Change Order.
- 5. Upon receipt of Owner-executed Change Order, Engineer will transmit two copies to Contractor, one copy to Resident Project Representative or other field representative, and retain one copy, or if Owner fails to execute the Change Order, Engineer will promptly so notify Contractor and transmit Owner's justification to Contractor.
- 6. Upon receipt of Owner-executed Change Order, Contractor shall:
  - a. Perform Work covered by Change Order.
  - b. Revise Schedule of Values to adjust Contract Price and submit with next Application for Payment.
  - c. Revise Progress Schedule to reflect changes in Contract Times, if any, and to adjust times for other items of Work affected by change.
  - d. Enter changes in Project record documents after completion of change related Work.
- B. In signing a Change Order, Owner and Contractor acknowledge and agree that:
  - Stipulated compensation (Contract Price or Contract Times, or both) set forth includes payment for (i) the Cost of the Work covered by the Change Order, (ii) Contractor's fee for overhead and profit, (iii) interruption of Progress Schedule, (iv) delay and impact, including cumulative impact, on other Work r the Contract Documents, and (v) extended overheads.

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- 2. Change Order constitutes full mutual accord and satisfaction for the change to the Work.
- 3. Unless otherwise stated in the Change Order, all requirements of the original Contract Documents apply to the Work covered by the Change Order.

## 1.05 COST OF THE WORK

- A. In determining the supplemental costs allowed in Paragraph 13.01.B.5 of the General Conditions for rental equipment and machinery, the following will apply.
- B. Rental of construction equipment and machinery and the parts thereof having a replacement value in excess of \$1,000, whether owned by Contractor or rented or leased from others, shall meet the following requirements:
  - 1. Full rental costs for leased equipment shall not exceed rates listed in the Rental Rate Blue Book published by Equipment Watch, as adjusted to the regional area of the Project. Owned equipment costs shall not exceed the single shift rates established in the Cost Reference Guide (CRG) published by Equipment Watch. The most recent published edition in effect at commencement of actual equipment use shall be used.
  - 2. Rates shall apply to equipment in good working condition. Equipment not in good condition, or larger than required, may be rejected by Engineer or accepted at reduced rates.
  - 3. Leased Equipment: For equipment leased or rented in arm's length transactions from outside vendors, maximum rates shall be determined by the following actual usage/Payment Category:
    - a. Less than 8 hours: Hourly rate.
    - b. 8 or more hours but less than 7 days: Daily rate.
    - c. 7 or more days but less than 30 days: Weekly rate.
    - d. 30 days or more: Monthly rate.
  - 4. Arm's length rental and lease transactions are those in which the firm involved in the rental or lease of equipment is not associated with, owned by, have common management, directorship, facilities and/or stockholders with the firm renting the equipment.
  - 5. Leased Equipment in Use: Actual equipment use time documented by Engineer shall be the basis that equipment was on and utilized at the Project Site. In addition to the leasing rate above, equipment operational costs shall be paid at the estimated hourly operating cost rate set forth in the Rental Rate Blue Book if not already included in the lease rate. Hours of operation shall be based upon actual equipment usage to the nearest quarter hour, as recorded by Engineer.

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- 6. Leased Equipment, When Idle (Standby): Idle or standby equipment is equipment onsite or in transit to and from the Work Site and necessary to perform the Work under the modification, but not in actual use. Idle equipment time, as documented by Engineer, shall be paid at the leasing rate determined above, excluding operational costs.
- 7. Owned and Other Equipment in Use: Equipment rates for owned equipment or equipment provided in other than arm's length transaction shall not exceed the single shift total hourly costs rate developed in accordance with the CRG and as modified herein for multiple shifts. This total hourly rate will be paid for each hour the equipment actually performs work. Hours of operation shall be based upon actual equipment usage as recorded by Engineer. This rate shall represent payment in full for Contractor's direct costs.
- 8. Owned and Other Equipment, When Idle (Standby): Equipment necessary to be onsite to perform the Work on single shift operations, but not utilized, shall be paid for at the ownership hourly expense rate developed in accordance with the CRG, provided its presence and necessity onsite has been documented by Engineer. Payment for idle time of portions of a normal workday, in conjunction with original contract Work, will not be allowed. In no event shall idle time claimed in a day for a particular piece of equipment exceed the normal Work or shift schedule established for the Project. It is agreed that this rate shall represent payment in full for Contractor's direct costs. When Engineer determines that the equipment is not needed to continuously remain at the Work Site, payment will be limited to actual hours in use.
- 9. Owned and Other Equipment, Multiple Shifts: For multiple shift operations, the CRG single shift total hourly costs rate shall apply to the operating equipment during the first shift. For subsequent shifts, up to two in a 24-hour day, operating rate shall be the sum of the total hourly CRG operating cost and 60 percent of the CRG ownership and overhaul expense. Payment for idle or standby time for second and third shifts shall be 20 percent of the CRG ownership and overhaul expense.
- 10. When necessary to obtain owned equipment from sources beyond the Project limits, the actual cost to transfer equipment to the Site and return it to its original location will be allowed as an additional item of expense. Move-in and move-out allowances will not be made for equipment brought to the Project if the equipment is also used on original Contract or related Work.
- 11. If the move-out destination is not to the original location, payment for move-out will not exceed payment for move-in.
- 12. If move is made by common carrier, the allowance will be the amount paid for the freight. If equipment is hauled with Contractor's own forces, rental will be allowed for the hauling unit plus the hauling unit operator's wage. If equipment is transferred under its own power, the rental will be 75 percent of the appropriate total hourly costs for the equipment, without attachments, plus the equipment operator's wage.

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- 13. Charges for time utilized in servicing equipment to ready it for use prior to moving and similar charges will not be allowed.
- 14. When a breakdown occurs on any piece of owned equipment, payment shall cease for that equipment and any other owned equipment idled by the breakdown.
- 15. If any part of the Work is shut down by Owner, standby time will be paid during nonoperating hours if diversion of equipment to other Work is not practicable. Engineer reserves the right to cease standby time payment when an extended shutdown is anticipated.
- 16. If a rate has not been established in the CRG for owned equipment, Contractor may:
  - a. If approved by Engineer, use the rate of the most similar model found, considering such characteristics as manufacturer, capacity, horsepower, age, and fuel type, or
  - b. Request Equipment Watch to furnish a written response for a rate on the equipment, which shall be presented to Engineer for approval; or
  - c. Request Engineer to establish a rate.

## 1.06 FIELD ORDER

- A. Engineer will issue Field Orders, with three copies to Contractor.
- B. Effective date of the Field Order shall be the date of signature by Engineer, unless otherwise indicated thereon.
- C. Contractor shall acknowledge receipt by signing and returning one copy to Engineer.
- D. Field Orders will be incorporated into subsequent Change Orders, as a no-cost change to the Contract.

## PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

# **END OF SECTION**

## SECTION 01 29 00 PAYMENT PROCEDURES

## PART 1 GENERAL

## 1.01 SUBMITTALS

- A. Informational Submittals:
  - 1. Schedule of Values: Submit on Contractor's standard form.
  - 2. Schedule of Estimated Progress Payments:
    - a. Submit with initially acceptable Schedule of Values.
    - b. Submit adjustments thereto with Application for Payment.
  - 3. Application for Payment.
  - 4. Final Application for Payment.

## 1.02 SCHEDULE OF VALUES

- A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement.
- B. Upon request of Engineer, provide documentation to support the accuracy of the Schedule of Values.
- C. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.
- D. Lump Sum Work:
  - 1. Reflect specified cash and contingency allowances and alternates, as applicable.
  - 2. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and contract closeout separately.
  - 3. Break down by Division 02 through 49 with appropriate subdivision of each specification.
- E. An unbalanced or front-end loaded schedule will not be acceptable.
- F. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.
- G. Submit Schedule of Values on a CD in a spreadsheet format compatible with latest version of MSExcel.

### SWF BAF IMPROVEMENTS

## 1.03 SCHEDULE OF ESTIMATED PROGRESS PAYMENTS

- A. Show estimated payment requests throughout Contract Times aggregating initial Contract Price.
- B. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

### 1.04 APPLICATION FOR PAYMENT

- A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.
- B. Use detailed Application for Payment Form suitable to Engineer and Owner.
- C. Provide separate form for each schedule as applicable.
- D. Include accepted Schedule of Values for each schedule or portion of lump sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.
- E. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.
- F. Preparation:
  - 1. Round values to nearest dollar.
  - 2. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Engineer.

### 1.05 PAYMENT

- A. Payment for all Lump Sum Work shown or specified in Contract Documents is included in the Contract Price. Payment will be based on a percentage complete basis for each line item of the accepted Schedule of Values.
- B. Payment for Lump Sum Work covers all Work specified or shown within the limits or Specification sections as follows:
  - 1. Limits of Work are as defined in Section 01 11 00, Summary of Work.

- C. Payment of 15 percent of manufacturer's quoted price for undelivered, Project-specific manufactured equipment will be made following Shop Drawing approval. Thereafter, monthly payments will be made based on progress of fabrication as determined by Engineer, but in no case will total of payments prior to delivery exceed 75 percent of manufacturer's quoted price.
- D. Failure of Contractor to continue compliance with above requirements shall give cause for Owner to withhold payments made for such equipment from future partial payments.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION (NOT USED)

## **END OF SECTION**

## SECTION 01 31 13 PROJECT COORDINATION

## PART 1 GENERAL

## 1.01 SUBMITTALS

- A. Informational:
  - 1. Statement of Qualification (SOQ) for land surveyor or civil engineer.
  - 2. Photographs:
    - a. Digital Images: Submit on compact disc containing images within 2 days of being taken.

## 1.02 RELATED WORK AT SITE

- A. General:
  - 1. Other work that is either directly or indirectly related to scheduled performance of the Work under these Contract Documents, listed henceforth, is anticipated to be performed at Site by others.
  - 2. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.
  - 3. Include sequencing constraints specified herein as a part of Progress Schedule.

### 1.03 UTILITY NOTIFICATION AND COORDINATION

- A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.
  - 1. Electricity Company: Florida Power and Light.
  - 2. Water Department: Public Works and Utilities, City of Marco Island.

### 1.04 PROJECT MILESTONES

- A. General: Include the Milestones specified herein as a part of the Progress Schedule required under Section 01 32 00, Construction Progress Documentation.
- B. Project Milestones: Generally described in the Agreement Form. Following is a detailed description of each:
  - 1. Delivery of equipment to Site.
  - 2. Installation of equipment.

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- 3. Equipment startup.
- 4. Substantial completion.

## 1.05 WORK SEQUENCING/CONSTRAINTS

- A. Include the following work sequencing in the Progress Schedule:
  - 1. Coordinate with Owner to remove and cap the piping connection from the existing lake transfer pump to the existing lake transfer discharge header.
  - 2. Demolish the existing lake transfer pump and associated equipment, piping and appurtenances, while the existing standby lake transfer pump remains operational and continues with normal operations.
  - 3. Install, test and disinfect the new lake transfer pump and associated equipment, piping and appurtenances. Coordinate with the Owner to connect the new piping with the existing piping to minimize interference with operations.
  - 4. Construct the remaining items of the work, with exception of the lake transfer pump station discharge header replacement, while the standby lake transfer pump remains operational and continues with normal operation. Install piping and inline accessories to the extent possible without interfering with normal operations. Do not connect piping to existing equipment at this time but install all new piping up to the connection points. This will avoid interruptions in plant operations.
  - 5. At this time the filtration system and associated equipment will be constructed with the exception of making the final connections to the existing piping, electrical equipment and I&C network. Program the existing work stations and SCADA as required. Coordinate the required programming with Owner. Additional and more specific information of transition is provided in the individual process-mechanical, electrical and I&C specification sections.
  - 6. Disinfect system in accordance with Section 33 13 00, Disinfection of Water Utility Distribution Facilities. The disinfection plan must be submitted and approved by Owner prior to commencing the disinfection of the system.
  - 7. Prepare connections to the existing plant to minimize time required for lake transfer and ASR feed shutdown(s). Obtain Owner's approval for any required process shutdown(s). Make the connections to existing piping from the filter influent pumps, filter backwash supply feed line, and filter effluent line and I&C connections.

- 8. After the filter feed, filter backwash supply, and filter effluent connections are made, the filtration process will be ready for testing and startup. Obtain Owner's approval before changing distribution of flows to the new filters and existing ground storage tank. The Contractor is to develop a test plan and select the best discharge location to flush, test and dispose of startup waters, based on anticipated flows and duration of the flushing and testing period(s) while staying in compliance with local regulations. The plan must be submitted and approved by the Owner prior to commencing. Some of the lake transfer water will be distributed to each of the new pressure filters. This operation will continue until each of the filters, air scour blower, backwash pump, and lake transfer pump have been tested and cleared for system startup.
- 9. When the pressure filters have been cleared and approved for use and placed in service, the existing lake transfer pump station effluent header piping can be replaced to become the new filter bypass piping. Coordinate with the Owner to disconnect the existing piping and connect the new piping to minimize interference with operations. Install, test and disinfect the new filter bypass piping and connections.

## 1.06 FACILITY OPERATIONS

- A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.
- B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner's operations.
- C. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner's facility.
- D. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.
- E. Process or Facility Shutdown:
  - 1. All process or facility shutdowns must be approved by the Owner and the Contractor shall coordinate with the Owner to schedule the shutdown.

- 2. The following shall require plant or process shutdown at some time during the Work:
  - a. Existing lake transfer pump station effluent header for the duration of time needed to disconnect the existing lake transfer pump effluent piping from the common lake transfer pump station effluent header, but not to exceed 4 hours.
  - b. Existing lake transfer pump station effluent header for the duration of time needed to complete the new lake transfer pump discharge pipe connections to the lake transfer pump station effluent header, but not to exceed 4 hours.
  - c. Existing lake transfer pump station effluent header for the duration of time needed to complete the new pressure filter feed piping connections to the existing lake transfer pump station effluent header, but not to exceed 8 hours.
  - d. Existing lake transfer pump station effluent header for the duration of time needed to complete the new pressure filter effluent piping connections to the existing lake transfer pump station effluent header, but not to exceed 8 hours.
  - e. Existing ground storage tank east feed pipe (including ASR well feed to the ground storage tank and lake transfer pump station/new pressure filter feed to the ground storage tank) for the duration of time needed to complete the new backwash supply pump connections to the existing ground storage tank east feed pipe, but not to exceed 8 hours.
  - f. New pressure filter feed piping for the duration of time needed to disconnect the existing lake transfer pump station effluent header connection from the pressure filter feed piping, but not to exceed 4 hours.
  - g. New pressure filter effluent header for the duration of time needed to disconnect the existing lake transfer pump station effluent header from the new pressure filter effluent header, but not to exceed 4 hours.
  - h. Existing raw water pump station bypass (to the ground storage tank) header for the duration of time needed to disconnect the existing lake transfer pump station effluent header from the raw water pump station bypass (to the ground storage tank) header, but not to exceed 4 hours.
  - i. New pressure filter feed piping for the duration of time needed to complete the new pressure filter bypass header connection to the new pressure filter feed pipe, but not to exceed 4 hours.
  - j. New pressure filter effluent header for the duration of time needed to complete the connection to the new pressure filter bypass piping to the new pressure filter effluent header, but not to exceed 4 hours.

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- k. Existing raw water pump station bypass (to the ground storage tank) header for the duration of time needed to complete the new pressure filter bypass line connections to the raw water pump station bypass (to the ground storage tank) header, but not to exceed 4 hours.
- 3. Provide 14 days advance written request for approval of need to shut down a process or facility to Owner and Engineer.
- 4. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.
- F. Do not proceed with Work affecting a facility's operation without obtaining Owner's and Engineer's advance approval of the need for and duration of such Work.
- G. Relocation of Existing Facilities:
  - 1. During construction, it is expected that minor relocations of Work will be necessary.
  - 2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
  - 3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
  - 4. Perform relocations to minimize downtime of existing facilities.
  - 5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.
  - 6. All required plant disruptions will require the approval of the Owner. Each disruption of services will be coordinated with the Owner. The Owner will have the sole authority on the timing and duration of each stoppage.

# 1.07 ADJACENT FACILITIES AND PROPERTIES

## A. Examination:

- 1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
- 2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

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## B. Documentation:

- 1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs.
- 2. Upon receipt, Engineer will review, sign, and return one record copy of documentation to Contractor to be kept on file in field office.
- 3. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of adjacent property owners, Contractor, and Owner.

## 1.08 CONSTRUCTION PHOTOGRAPHS

- A. General:
  - 1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
  - 2. Photography shall be by a professional commercial photographer, experienced in shooting interior/exterior construction photos, in daylight and nighttime conditions, and in good and inclement weather.
  - 3. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.
  - 4. Film Images: Handling and development shall be done by a commercial laboratory.
- B. Preconstruction and Post-Construction:
  - 1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take a minimum of 50 photographs of Site and property adjacent to perimeter of Site.
  - 2. Particular emphasis shall be directed to structures both inside and outside the Site.
  - 3. Format: Digital, minimum resolution of 1152 by 864 pixels and 24-bit, millions of color.
- C. Construction Progress Photos:
  - 1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
  - 2. Weekly: Take 50 photographs using digital, minimum resolution of 1152 by 864 pixels and 24-bit, millions of color.

- D. Documentation:
  - 1. Digital Images:
    - a. Archive using a commercially available photo management company.
    - b. Label each disk with Project and Owner's name, and month and year images were produced.

## 1.09 REFERENCE POINTS AND SURVEYS

- A. Owner's Responsibilities:
  - 1. Establish bench marks convenient to Work.
  - 2. Establish horizontal reference points or coordinate system with bench marks and reference points for Contractor's use as necessary to lay out Work.
  - 3. Establish baseline from which facilities may be located.
- B. Location and elevation of bench marks are shown on the Drawings.
- C. Contractor's Responsibilities:
  - 1. Provide additional survey and layout required to layout the Work.
  - 2. Notify Engineer at least 3 working days in advance of time when grade and line to be provided by Owner will be needed.
  - 3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
  - 4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
  - 5. Maintain complete accurate log of survey work as it progresses as a Record Document.
  - 6. On request of Engineer, submit documentation.
  - 7. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
    - a. Establish control points, lines, and easement boundaries.
    - b. Check layout, survey, and measurement work performed by others.
    - c. Measure quantities for payment purposes.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

#### 3.01 CUTTING, FITTING, AND PATCHING

- A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.
- B. Obtain prior written authorization of Engineer and before commencing Work to cut or otherwise alter:
  - 1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
  - 2. Weather-resistant or moisture-resistant elements.
  - 3. Efficiency, maintenance, or safety of element.
  - 4. Work of others.
- C. Refinish surfaces to provide an even finish.
  - 1. Refinish continuous surfaces to nearest intersection.
  - 2. Refinish entire assemblies.
  - 3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.
- D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on the Drawings.
- E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.
- F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.
- G. Remove specimens of installed Work for testing when requested by Engineer.

#### 3.02 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION," are part of this Specification.
  - 1. Subsurface Soil Exploration and Geotechnical Engineering Evaluation.

### **END OF SECTION**

PROJECT COORDINATION 01 31 13 - 8

#### SUBSURFACE SOIL EXPLORATION MARCO ISLAND SOURCE WATER FACILITY NAPLES, COLLIER COUNTY, FLORIDA



#### **CORPORATE HEADQUARTERS**

8008 S. Orange Avenue, Orlando, FL 32809 - Phone: (407) 855-3860 Fax: (407) 859-8121

**Branch Office Locations** 

Florida: Bartow, Cocoa, Fort Myers, Miami, Orlando, Port St. Lucie, Sarasota, Tallahassee, Tampa, West Palm Beach Louisiana: Baton Rouge, New Orleans, Shreveport

#### MEMBERS:

ASTM International American Concrete Institute Geoprofessional Business Association Society of American Military Engineers American Council of Engineering Companies



Ardaman Project No. 22-33-4531 August 18, 2022

#### Jacobs

550 W. Cypress Creek Rd., Suite 400 Fort Lauderdale, FL 33309

Attention: GJ Schers, PMP

Subject: Subsurface Soil Exploration Marco Island Source Water Facility. Naples, Collier County, Florida

Dear Mr. Schers,

As requested and authorized by **Jacobs**, Ardaman & Associates, Inc. (Ardaman) has completed a subsurface soil exploration program for the subject project. The purposes of this program were to evaluate the general subsurface conditions at the southeastern region of the site.

This report documents our findings and conclusions. It has been prepared for the exclusive use of **Jaobs** for specific application to the subject project in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

#### SCOPE

The scope of our services was limited to the following items:

- 1. Conducting one (1) Standard Penetration Test (SPT) boring and one (1) hand auger boring to evaluate the nature and condition of the subsurface soils.
- 2. Reviewing each soil sample obtained in our field exploration program by a geotechnical engineer in our laboratory for further identification and assignment of laboratory tests.
- 3. Performing the laboratory tests on selected samples in accordance with Jacobs' requests, including one (1) full corrosion series test on soil samples obtained at the hand auger boring location.
- 4. Preparing this report to document the results of our field exploration.

## SITE LOCATION AND PROJECT DESCRIPTION

The project site is located at the Marco Island Source Water Facility at 7130 Collier Blvd. in Naples, Collier County, Florida. It is our understanding that previous geotechnical explorations were performed at the site, but further information about the subsurface conditions at the southeastern region of the site are needed for the new piping and filter/feed PS structure. A **Site Location Map** showing the approximate project location is presented as **Figure 1**.

## FIELD EXPLORATION PROGRAM

Our field exploration program included performing one (1) SPT boring to a depth of 50 feet below the existing ground surface for the filter and feed PS structure and one (1) hand auger boring to a depth of 6 feet below the existing ground surface for the new piping. The SPT boring was conducted using methods consistent with ASTMD D-1586. The equipment and procedures used in the SPT and auger borings are described in detail in the **Appendix**.

The locations of the borings are shown on the attached **Figure 2 – Boring Location Map**. These locations were determined in the field by Global Positioning System (GPS) utilizing handheld GPS equipment and coordinates obtained from Google Earth. Therefore, the locations indicated should be considered accurate only to the degree implied by the method of measurement used. If more precise locations of the borings are desired, then we recommend that a registered land surveyor be employed to locate them on site. GPS coordinates of each boring location are provided on the attached **SPT Boring Profile** and **Auger Boring Profile** shown in **Figures 3 & 4**, respectively.

## LABORATORY TESTING PROGRAM

Representative soil samples obtained during our field sampling operation were packaged and transferred to our office for a geotechnical engineer to confirm soil classifications. Specific laboratory tests were performed on selected samples as requested by Jacobs. The soil descriptions shown on the boring profiles are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures. Results from the laboratory testing are included in the attached **SPT Boring Profile** and **Auger Boring Profile**, as well as on the **Grain Size Distribution Curves** sheets shown in **Figures 5 - 9**.

## **GENERAL SUBSURFACE CONDITIONS**

The general subsurface conditions encountered during the field exploration are shown on the attached soil boring profiles. Soil stratification is based on evaluation of recovered soil samples and interpretation of the field boring logs. The stratification lines represent the approximate



boundaries between the soil types, the actual transitions may be gradual.

In general, boring B-01 encountered loose to medium fine SAND (SP) and slightly silty fine SAND (SP-SM) with trace of rock fragments from the existing ground surface to a depth of approximately 3 feet, where a thin layer of hard LIMESTONE was encountered to a depth of approximately 4 feet. The limestone was underlain by medium silty fine SAND (SM), with varying concentrations of rock fragments, to a depth of approximately 7 ½ feet, at which point hard LIMESTONE was encountered to a depth of approximately 12 ½ feet. The hard limestone was underlain by loose to very dense silty fine SAND (SM) with varying concentrations of gravel (shell and/or rock fragments) to the boring termination depth of 50 feet.

Boring HA-01 encountered sands with less than 12% fines content, consisting of fine SAND (SP) and slightly silty fine SAND (SP-SM) with varying concentrations of rock fragments, from the existing ground surface to the boring termination depth of 6 feet.

Groundwater was encountered in the borings at depths ranging from approximately 4 to 4  $\frac{1}{2}$  feet during the time of our field exploration (July 2022). The groundwater depths shown on the boring profiles represent the groundwater surface encountered on the dates shown. Fluctuation in groundwater level should be anticipated throughout the year due to seasonal variations in rainfall, and other factors.

# **CORROSION SERIES TEST RESULTS**

One (1) soil sample was obtained from the location of boring HA-01 for environmental corrosion tests consisting of soil pH (FM 5-550), resistivity (FM 5-551), chlorides (FM 5-552) and sulfates (FM 5-553). The results are summarized below.

Sample Location	Depth (ft.)	рН	Resistivity (ohm-cm)	Chlorides (ppm)	Sulfates (ppm)	Substructure Environmental Classification	
						Steel	Concrete
HA-01	2 - 4	8.56	19,270	BDL	3	Slightly Aggressive	Slightly Aggressive

Note: "BDL" refers to below detection level.

According to the criteria described in the Florida Department of Transportation (FDOT) Structures Manual, Volume 1, Section 1.3 (January 2022), the soils are slightly aggressive for contact with steel and concrete structures.



## **GENERAL COMMENTS**

The discussions in this report are based on the data obtained from the soil borings performed at the approximate locations indicated on the attached **Figure 2 – Boring Location Map**. This report does not reflect any variations that may occur between the borings. The nature and extent of variations may not become evident until during the final subsurface soil exploration program and/or construction. If variations then appear evident, it will be necessary for a re-evaluation of the preliminary discussion in this report.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and may be encountered. The boring profiles and related information are based on the driller's logs and visual evaluation of selected sample in the laboratory. The delineation between soil types shown on the boring profiles is approximate and the description represents our interpretation of subsurface conditions at the designated boring locations and on the particular date drilled.



If you have any questions about this report, please contact this office.

Very truly yours,

## Ardaman & Associates, Inc.

be

Cory C. Schulte, E.I. Staff Engineer



This document has been digitally signed and sealed by

on the date adjacent to the seal.

Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Ivan F. Sokolic, P.E. Senior Engineer/Branch Manager

CCS:IFS


# **ATTACHMENTS**

- SITE LOCATION MAP (FIGURE 1)
- BORING LOCATION MAP (FIGURE 2)
- SPT BORING PROFILE (FIGURES 3)
- AUGER BORING PROFILE (FIGURE 4)
- GRAIN SIZE DISTRIBUTION CURVES (FIGURES 5 9)





REFERENCE: GOOGLE EARTH PRO 2021, IMAGERY DATED 1/2021

22.15:8





APPROXIMATE SITE LOCATION



APPROXIMATE SCALE



# SITE LOCATION MAP

Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants

MARCO ISLAND SOURCE WATER FACILITY NAPLES COLLIER COUNTY, FLORIDA

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REFERENCE: GOOGLE EARTH PRO 2021, IMAGERY DATED 1/2021

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LEGEND



APPROXIMATE LOCATION OF AUGER BORINGS



APPROXIMATE LOCATION OF SPT BORINGS



APPROXIMATE SCALE



# BORING LOCATION MAP

Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants

MARCO ISLAND SOURCE WATER FACILITY NAPLES COLLIER COUNTY, FLORIDA

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- (E)Gravelly

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MRCO ISLAND SOURCE WATER FACILITY, NAPLES, COLLIER CO\06 PREPARED DRAI

::\GE0\PR0JECTS\2022\22-33-4531 JAC0BS

## <u>LEGEND</u>

SAND: Sand with  $\leq 12\%$  fines Silty SAND: Sand with 12% to 50% Silt HARD LIMESTONE: Limestone with N > 50

#### ADDITIONAL SOIL COMPONENTS

SPT STANDARD PENETRATION TEST SM UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP SYMBOL SUBSCRIPT INDICATING ADDITIONAL COMPONENTS OF SOIL SAMPLE SPT N-VALUE IN BLOWS PER FOOT 50/4" NUMBER OF BLOWS FOR GIVEN PENETRATION (I.E. 50 BLOWS FOR 4 INCHES) GROUNDWATER LEVEL MEASURED ON DATE DRILLED NATURAL MOISTURE CONTENT (%) % PASSING #200 SIEVE LOSS OF DRILLING FLUID CIRCULATION SPT BORING PROFILE Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants MARCO ISLAND SOURCE WATER FACILITY NAPLES

COLLIER COUNTY, FLORIDA					
drawn by: CS	CHECKED BY: IS	DATE: 08/18/2022			
FILE NO. 22-33-4	4531 APPROVED BY: IS	FIGURE: 3			



SAND: Sand with  $\leq$  12% fines

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP SYMBOL SUBSCRIPT INDICATING ADDITIONAL COMPONENTS OF SOIL SAMPLE GROUNDWATER LEVEL MEASURED ON DATE DRILLED NATURAL MOISTURE CONTENT (%) % PASSING #200 SIEVE

## ADDITIONAL SOIL COMPONENTS

AUGER BORING PROFILE						
Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants						
MARCO ISLAND SOURCE WATER FACILITY NAPLES COLLIER COUNTY, FLORIDA						
DRAWN BY: CS CHECKED BY: IS DATE: 08/18/2022						
FILE NO. 22-33-4531 APPROVED BY: IS FIGURE: 4						











# **APPENDIX**

• SOIL BORING, SAMPLING AND TESTING METHODS PROJECT SOIL DESCRIPTION PROCEDURE – UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)



#### SOIL BORING, SAMPLING AND TESTING METHODS

#### STANDARD PENETRATION TEST

The Standard Penetration Test (SPT) is a widely accepted method of in-situ testing of foundation soils (ASTM D-1586). A 2 ft (0.6 m) long, 2 in (50 mm) O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 in (0.45 m) into the ground by successive blows of a 140 lb (63.5 Kg) hammer freely dropping 30 in (0.76 m). The number of blows needed for each 6 in (0.15 m) of penetration is recorded. The sum of the blows required for penetration of the second and third 6 in (0.15 m) increments penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual description of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load. The following tables relate N-values to a qualitative description of soil density and, for cohesive soils, an approximate unconfined compressive strength ( $Q_u$ ):

Cohesionless Soils:	N-Value Safety Hammer	N-Value Auto Hammer	Description	Relative Density
	< 4	< 3	Very loose	0 - 15%
	4 - 10	3 - 8	Loose	>15% - 35%
	11 - 30	9 - 24	Medium	>35% - 65%
	31 - 50	25 - 40	Dense	>65% - 85%
	> 50	> 40	Very dense	>85% - 100%
Cohesive Soils:	N-Value Safety Hammer	N-Value Auto Hammer	Description	Unconfined Compressive Strength, Qu
	< 2	< 1	Very soft	< 0.25 tsf (25 kPa)
	2 - 4	1 - 3	Soft	0.25 - 0.50 tsf (25 - 50 kPa)
	5 - 8	4 - 6	Firm	>0.50 - 1.0 tsf (50 - 100 kPa)
	9 - 15	7 - 12	Stiff	>1.0 - 2.0 tsf (100 - 200 kPa)
	16 - 30	13 - 24	Very stiff	>2.0 - 4.0 tsf (200 - 400 kPa)
	> 30	> 24	Hard	> 4.0 tsf (400 kPa)

The tests are usually performed at 5 ft (1.5 m) intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed by backfilling with neat cement.

Representative split-spoon samples from each sampling interval and from different strata are brought to our laboratory in air-tight jars for classification and testing, if necessary. Afterwards, the samples are discarded unless prior arrangements have been made.

#### HAND AUGER BORINGS

Hand auger borings are used, if soil conditions are favorable, when the soil strata are to be determined within a shallow (approximately 5 ft [1.5 m]) depth or when access is not available to power drilling equipment. A 3 in (75 mm) diameter hand bucket auger with a cutting head is simultaneously turned and pressed into the ground. The bucket auger is retrieved at approximately 6 in (0.15 m) intervals and its contents emptied for inspection. Sometimes post-hole diggers are used, especially in the upper 3 ft (1 m) or so. The soil sample obtained is described and representative samples put in bags or jars and transported to the laboratory for classification and testing, if necessary.

#### **POWER AUGER BORINGS**

Auger borings are used when a relatively large, continuous sampling of soil strata close to the ground surface is desired. A 4 in (100 mm) diameter, continuous flight, helical auger with a cutting head at its end is screwed into the ground in 5 ft (1.5 m) sections. It is powered by the rotary drill rig. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is described and representative samples put in bags or jars and returned to the laboratory for classification and testing, if necessary.

#### LABORATORY TEST METHODS

Soil samples returned to our laboratory are looked at again by a geotechnical engineer or geotechnician to obtain more accurate descriptions of the soil strata. Laboratory testing is performed on selected samples as deemed necessary to aid in soil classification and to help define engineering properties of the soils. The test results are presented on the soil boring logs at the depths at which the respective sample was recovered, except that grain-size distributions or selected other test results may be presented on separate tables, figures or plates as discussed in this report, the results of which will be located in an Appendix. The soil descriptions shown on the logs are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures.

#### THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHWEST FLORIDA <sup>(1)</sup> For use with the ASTM D-2487 Unified Soil Classification System CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

BOULDERS (>12 in [300 mm]) and COBBLES (3 in [75 mm] to 12 in [300 mm]):

	<u>GRAVEL:</u>	Coarse G Fine Grav	ravel: el:	¾ in (19 No. 4 (4	mm) to 3 in (75 mm) .75 mm) Sieve to ¾ in	(19 mm)		
		Descriptiv	e Adjectiv	/es:				
		0 – 5%	-	no men	tion of gravel in descri	ption		
		>5% – 15	% -	trace				
		>15% – 3	0% -	some				
		>30% – 5	0% -	gravelly	(shell, limerock, cem	ented sands)		
	SANDS: (	Coarse Sand:	No. 1	0 (2 mm) Sieve	e to No. 4 (4.75 mm) S	ieve		
		Medium sand:	No. 4	0 (425 <i>µ</i> m) Sie	eve to No. 10 (2 mm) S	lieve		
	F	Fine sand:	No. 2	00 (75 μm) Sie	ve to No. 40 (425 µm	) Sieve		
		Descriptiv	e Adiectiv	/es:	····	,		
		0 – 5%	-	no men	tion of sand in descrip	tion		
		>5% – 15	% -	trace				
		>15% – 3	0% -	some				
		>30% – 5	0% -	sandy				
	SILT/CLAY:	<#200 (75 µm)	Sieve					
	Silt Silt Cla	y or Silt: PI < 4 y Clayey or Silty yey or Clay: PI >	Clay: 4 ≤ • 7	PI ≤ 7				
		Descriptiv	e Adiectiv	165.				
		<u>0 – 5%</u>			clean (no mention o	f silt or clay in descriptio	n)	
		>5% - 12	%		slightly		,	
		>12% - 3	0%		clavev silty or silty	clavev		
		>30% - 5	0%		verv	olayoy		
		- 0070 0	0 /0		vory			
	ORGANIC SC	)II S						
	Organic	Content	Descript	tive Adjectives:		Classification:		
	organic	Ooment	Descript	ine Aujeeines.		<u>olassification.</u>		
	0 – 2.5	5%	no ment	ion of organics	in description	see above		
	2.6 – 5	5%	slightly o	organic		see above		
	>5 – 2	0%	organic			add "with organic	fines" to group name	
	>20-75	5%	highly o	rganic sand or	muck sandy peat	Peat (PT)		
	>75%		fibrous p	peat		Peat (PT)		
ST		I AND STRUCT						
						Decembratives T	Thistory	
1 10	eenntiva larm'					I DECRIMINA LARM'	INCONCES.	

Descriptive Term:	Thickness:	Descriptive	<u>e Term:</u> <u>Thickness:</u>
seam:	less than ½ in (13 mm) thick	frequent:	more than 1 per ft of thickness
layer:	<sup>1</sup> / <sub>2</sub> to 12 in (13 to 300 mm) thick	calcareous:	containing calcium carbonate (reaction to diluted HCL)
stratum:	more than 12 in (300 mm) thick	hardpan:	spodic horizon usually medium dense
pocket:	small, erratic deposit, usually less than 1 ft	marl:	mixture of carbonate clays, silts, shells and sands.
occasional:	1 or less per ft of thickness		

#### **ROCK CLASSIFICATION:**

<u>Description:</u> Hard Limestone or Caprock: N-values >50 bpf Soft Weathered Limestone: N-values  $\leq$  50 bpf

(1) This soil description procedure was developed specifically for projects in southwest Florida because it is believed that the terminology will be better understood as a result of local practice. It is not intended to supplant other visual-manual classification procedures for description and identification of soils such as ASTM D-2488.

#### UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

					Soil Classification
Criteria for Assigning	g Group Symbols and	Group Names Usin	g Laboratory Tests <sup>A</sup>	Group Symbol	Group Name <sup>8</sup>
	Gravels:	Clean Gravels:	$C_u > 4$ and $1 < C_c < 3^E$	GW	Well graded gravel <sup>F</sup>
	More than 50% of	Less than 5% fines <sup>C</sup>	$C_u < 4$ and/or $1 > C_c > 3^E$	GP	Poorly graded gravel <sup>F</sup>
	coarse fraction retained	Gravels with Fines:	Fines classify as ML or MH	GM	Silty gravel <sup>F,G,H</sup>
Coarse Grained Soils:	on No. 4 sieve	More than 12% fines $^{\rm C}$	Fines classify as CL or CH	GC	Clayey gravel <sup>F,G,H</sup>
on No. 200 sieve	Sands: 50% or more of coarse fraction passes No. 4	Clean Sands: Less than 5% fines <sup>D</sup>	$C_u \ge 6 \text{ and } 1 \le C_c \le 3^E$	SW	Well graded sand
			$C_u \le 6$ and/or $1 \ge C_c \ge 3^E$	SP	Poorly graded sand
		Sands with Fines: More than 12% fines <sup>D</sup>	Fines classify as ML or MH	SM	Silty sand <sup>G,H,I</sup>
	sieve		Fines classify as CL or CH	SC	Clayey sand <sup>G,H,I</sup>
			PI > 7 and plots on or above "A" line	CL	Lean clay <sup>K,L,M</sup>
	Silts and Clays: Liquid limit less than 50	Inorganic:	PI < 4 or plots below "A" line <sup>1</sup>	ML	Silt <sup>K,L,M</sup>
			Liquid limit - oven dried (< 0.75)	OL	Organic clay <sup>K,L,M,N</sup>
Fine Grained Soils:		Organic:	Liquid limit - not dried (< 0.75)	OL	Organic silt <sup>K,L,M,O</sup>
No. 200 sieve		Inorganic:	PI plots on or above "A" line	CH	Fat clay <sup>K,L,M</sup>
	Silts and Clays:		PI plots below "A" line	MH	Elastic silt <sup>K,L,M</sup>
	Liquid limit 50 or more	o	Liquid limit - oven dried (< 0.75)	ОН	Organic clay <sup>K,L,M,P</sup>
		Organic:	Liquid limit - not dried (< 0.75)	OH	Organic clay <sup>K,L,M,Q</sup>
Highly organic soils:	Primari	ly organic matter, dark in	n color, and organic odor	PT	Peat

<sup>A</sup> Based on the material passing the 3-in (75-mm) sieve.

- <sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- <sup>c</sup> Gravels with 5 to 12% fines require dual symbols: GW-GM well graded gravel with silt, GW-GC well graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- <sup>D</sup> Sands with 5 to 12% fines require dual symbols: SW-SM well graded sand with silt, SW-SC well graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

$$^{E}Cu = D_{60}/D_{10}$$
 Cc =  $(^{D_{30})}$ 

 $^{\text{F}}$  If soil contains  $\geq$  15% sand, add "with sand" to group name.

<sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

- <sup>H</sup> If fines are organic, add "with organic fines" to group name.
- $^{\rm I}$  If soil contains  $\geq$  15% gravel, add "with gravel" to group name.
- <sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- <sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
- $^{L}$  If soil contains  $\geq$  30% plus No. 200 predominantly sand, add "sandy" to group name.
- $^{\rm M}$  If soil contains  $\geq$  30% plus No. 200 predominantly gravel, add "gravelly" to group name.
- <sup>N</sup> PI  $\geq$  4 and plots on or above "A" line.
- <sup>o</sup> PI < 4 or plots below "A" line.
- <sup>P</sup> PI plots on or above "A" line.
- <sup>Q</sup> PI plots below "A" line.



LIQUID LIMIT (LL)

#### SECTION 01 31 19 PROJECT MEETINGS

#### PART 1 GENERAL

#### 1.01 GENERAL

A. Engineer will schedule physical arrangements for meetings throughout progress of the Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.

#### 1.02 PRECONSTRUCTION CONFERENCE

- A. Contractor shall be prepared to discuss the following subjects, as a minimum:
  - 1. Required schedules.
  - 2. Status of Bonds and insurance.
  - 3. Sequencing of critical path work items.
  - 4. Progress payment procedures.
  - 5. Project changes and clarification procedures.
  - 6. Use of Site, access, office and storage areas, security and temporary facilities.
  - 7. Major product delivery and priorities.
  - 8. Contractor's safety plan and representative.
- B. Attendees will include:
  - 1. Owner's representatives.
  - 2. Contractor's office representative.
  - 3. Contractor's resident superintendent.
  - 4. Contractor's quality control representative.
  - 5. Subcontractors' representatives whom Contractor may desire or Engineer may request to attend.
  - 6. Engineer's representatives.
  - 7. Others as appropriate.

#### 1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 00, Construction Progress Documentation.

#### SWF BAF IMPROVEMENTS

#### 1.04 PROGRESS MEETINGS

- A. Engineer will schedule regular progress meetings at Site, conducted weekly to review the Work progress, Progress Schedule, Schedule of Submittals, Application for Payment, contract modifications, and other matters needing discussion and resolution.
- B. Attendees will include:
  - 1. Owner's representative(s), as appropriate.
  - 2. Contractor, Subcontractors, and Suppliers, as appropriate.
  - 3. Engineer's representative(s).
  - 4. Others as appropriate.

#### 1.05 QUALITY CONTROL MEETINGS

- A. In accordance with Section 01 45 16.13, Contractor Quality Control.
- B. Scheduled by Engineer on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of the Work and work of other Contractors.
- C. Attendees will include:
  - 1. Contractor.
  - 2. Contractor's designated quality control representative.
  - 3. Subcontractors and Suppliers, as necessary.
  - 4. Engineer's representatives.

#### 1.06 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) COORDINATION MEETINGS

- A. Engineer will schedule meetings at Site, conducted as needed, to review specific requirements of PICS work.
- B. Attendees will include:
  - 1. Contractor.
  - 2. Owner.
  - 3. PICS Subcontractor/Installer.
  - 4. Engineer's representatives.

#### 1.07 PREINSTALLATION MEETINGS

A. When required in individual Specification sections, convene at Site prior to commencing the Work of that section.

- B. Require attendance of entities directly affecting, or affected by, the Work of that section.
- C. Notify Engineer 4 days in advance of meeting date.
- D. Provide suggested agenda to Engineer to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

#### 1.08 FACILITY STARTUP MEETINGS

- A. Schedule and attend a minimum of two facility startup meetings. The first of such meetings shall be held prior to submitting Facility Startup Plan, as specified in Section 01 91 14, Equipment Testing and Facility Startup, and shall include preliminary discussions regarding such plan.
- B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.
- C. Attendees will include:
  - 1. Contractor.
  - 2. Contractor's designated quality control representative.
  - 3. Subcontractors and equipment manufacturer's representatives whom Contractor deems to be directly involved in facility startup.
  - 4. Engineer's representatives.
  - 5. Owner's operations personnel.
  - 6. Others as required by Contract Documents or as deemed necessary by Contractor.

#### 1.09 OTHER MEETINGS

- A. In accordance with Contract Documents and as may be required by Owner and Engineer.
- PART 2 PRODUCTS (NOT USED)
- PART 3 EXECUTION (NOT USED)

#### **END OF SECTION**

#### SECTION 01 32 00 CONSTRUCTION PROGRESS DOCUMENTATION

#### PART 1 GENERAL

#### 1.01 SUBMITTALS

- A. Informational Submittals:
  - 1. Preliminary Progress Schedule: Submit within 14 days after Effective Date of the Agreement.
  - 2. Detailed Progress Schedule:
    - a. Submit initial Detailed Progress Schedule within 60 days after Effective Date of the Agreement.
    - b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
  - 3. Submit with Each Progress Schedule Submission:
    - a. Contractor's certification that Progress Schedule submission is actual schedule being used for execution of the Work.
    - b. Disk file compatible with latest version of Project Planner (P6) by Primavera Systems, Inc.
    - c. Progress Schedule: 4 legible copies.
    - d. Narrative Progress Report: Same number of copies as specified for Progress Schedule.
  - 4. Prior to final payment, submit a final Updated Progress Schedule.

#### 1.02 PRELIMINARY PROGRESS SCHEDULE

- A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration defined in the purchasing documents and the Bid Form, and a summary of balance of Project through Final Completion.
- B. Show activities including, but not limited to the following:
  - 1. Notice to Proceed.
  - 2. Permits.
  - 3. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
  - 4. Early procurement activities for long lead equipment and materials.
  - 5. Initial Site work.
  - 6. Earthwork.
  - 7. Specified Work sequences and construction constraints.
  - 8. Contract Milestone and Completion Dates.
  - 9. Owner-furnished products delivery dates or ranges of dates.

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- 10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
- 11. System startup summary.
- 12. Project close-out summary.
- 13. Demobilization summary.
- C. Update Preliminary Progress Schedule monthly as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.
- D. Format: In accordance with Article Progress Schedule— Critical Path Network.

#### 1.03 DETAILED PROGRESS SCHEDULE

- A. In addition to requirements of General Conditions, submit Detailed Progress Schedule beginning with Notice to Proceed and continuing through Final Completion.
- B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.
- C. When accepted by Engineer, Detailed Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.
- D. Format: In accordance with Article Progress Schedule— Critical Path Network.
- E. Update monthly to reflect actual progress and occurrences to date, including weather delays.

#### 1.04 PROGRESS SCHEDULE—CRITICAL PATH NETWORK

- A. General: Comprehensive computer-generated schedule using CPM, generally as outlined in Associated General Contractors of America (AGC) 580, "Construction Project Planning and Scheduling Guidelines." If a conflict occurs between the AGC publication and this specification, this specification shall govern.
- B. Contents:
  - 1. Schedule shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
  - 2. Identify Work calendar basis using days as a unit of measure.

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- 3. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work.
- 4. Identify the Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
- 5. Reflect sequences of the Work, restraints, delivery windows, review times, Contract Times and Project Milestones set forth in the Agreement and Section 01 31 13, Project Coordination.
- 6. Include as applicable, at a minimum:
  - a. Obtaining permits, submittals for early product procurement, and long lead time items.
  - b. Mobilization and other preliminary activities.
  - c. Initial Site work.
  - d. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s) Subcontract Work.
  - e. Major equipment design, fabrication, factory testing, and delivery dates.
  - f. Sitework.
  - g. Concrete Work.
  - h. Structural steel Work.
  - i. Architectural features Work.
  - j. Conveying systems Work.
  - k. Equipment Work.
  - 1. Mechanical Work.
  - m. Electrical Work.
  - n. Instrumentation and control Work.
  - o. Interfaces with Owner-furnished equipment.
  - p. Other important Work for each major facility.
  - q. Equipment and system startup and test activities.
  - r. Project closeout and cleanup.
  - s. Demobilization.
- 7. No activity duration, exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 day nor more than 30 days, unless otherwise approved.
- 8. Activity duration for Submittal review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from Engineer.
- C. Network Graphical Display:
  - 1. Plot or print on paper not greater than 30 inches by 42 inches or smaller than 22 inches by 34 inches, unless otherwise approved.
  - 2. Title Block: Show name of Project, Owner, date submitted, revision or update number, and the name of the scheduler. Updated schedules shall indicate data date.

- 3. Identify horizontally across top of schedule the time frame by year, month, and day.
- 4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
- 5. Indicate the critical path.
- 6. Show, at a minimum, the controlling relationships between activities.
- 7. Plot activities on a time-scaled basis, with the length of each activity proportional to the current estimate of the duration.
- 8. Plot activities on an early start basis unless otherwise requested by Engineer.
- 9. Provide a legend to describe standard and special symbols used.
- D. Schedule Report:
  - 1. On 8-1/2-inch by 11-inch white paper, unless otherwise approved.
  - 2. List information for each activity in tabular format, including at a minimum:
    - a. Activity Identification Number.
    - b. Activity Description.
    - c. Original Duration.
    - d. Remaining Duration.
    - e. Early Start Date (Actual start on Updated Progress Schedules).
    - f. Early Finish Date (Actual finish on Updated Progress Schedules).
    - g. Late Start Date.
    - h. Late Finish Date.
    - i. Total Float.
  - 3. Sort reports, in ascending order, as listed below:
    - a. Activity number sequence with predecessor and successor activity.
    - b. Activity number sequence.
    - c. Early-start.
    - d. Total float.
- E. Cost-Loading:
  - 1. Note the estimated cost to perform each Work activity, with the exception of Submittals or Submittal reviews, in the network in a tabular listing.
  - 2. The sum of all activity costs shall equal the Contract Price. An unbalanced or front-end-loaded schedule will not be acceptable.
  - 3. The accepted cost-loaded Progress Schedule shall constitute the Schedule of Values specified in Section 01 29 00, Payment Procedures.

### 1.05 PROGRESS OF THE WORK

- A. Updated Progress Schedule shall reflect:
  - 1. Progress of Work to within 5 working days prior to submission.
  - 2. Approved changes in Work scope and activities modified since submission.
  - 3. Delays in Submittals or resubmittals, deliveries, or Work.
  - 4. Adjusted or modified sequences of Work.
  - 5. Other identifiable changes.
  - 6. Revised projections of progress and completion.
  - 7. Report of changed logic.
- B. Produce detailed subschedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.
- C. If an activity is not completed by its latest scheduled completion date and this failure is anticipated to extend Contract Times (or Milestones), submit, within 7 days of such failure, a written statement as to how nonperformance will be corrected to return Project to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.
- D. Owner may order Contractor to increase plant, equipment, labor force, or working hours if Contractor fails to:
  - 1. Complete a Milestone activity by its completion date.
  - 2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

#### 1.06 NARRATIVE PROGRESS REPORT

- A. Format:
  - 1. Organize same as Progress Schedule.
  - 2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.
- B. Contents:
  - 1. Number of days worked over the period, work force on hand, construction equipment on hand (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks).

- 2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
- 3. Contractor's plan for management of Site (for example, lay down and staging areas, construction traffic), use of construction equipment, buildup of trade labor, and identification of potential Contract changes.
- 4. Identification of new activities and sequences as a result of executed Contract changes.
- 5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
- 6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
- 7. Changes to activity logic.
- 8. Changes to the critical path.
- 9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
- 10. Steps taken to recover the schedule from Contractor-caused delays.

#### 1.07 SCHEDULE ACCEPTANCE

- A. Engineer's acceptance will demonstrate agreement that:
  - 1. Proposed schedule is accepted with respect to:
    - a. Contract Times, including Final Completion and all intermediate Milestones, are within the specified times.
    - b. Specified Work sequences and constraints are shown as specified.
    - c. Specified Owner-furnished Equipment or Material arrival dates, or range of dates, are included.
    - d. Access restrictions are accurately reflected.
    - e. Startup and testing times are as specified.
    - f. Submittal review times are as specified.
    - g. Startup testing duration is as specified and timing is acceptable.
  - 2. In all other respects, Engineer's acceptance of Contractor's schedule indicates that, in Engineer's judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

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- B. Unacceptable Preliminary Progress Schedule:
  - 1. Make requested corrections; resubmit within 10 days.
  - 2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, including updating schedule on a monthly basis to reflect actual progress and occurrences to date.
- C. Unacceptable Detailed Progress Schedule:
  - 1. Make requested corrections; resubmit within 10 days.
  - 2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.
- D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer's acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

#### 1.08 ADJUSTMENT OF CONTRACT TIMES

- A. Reference General Conditions and Section 01 26 00, Contract Modification Procedures.
- B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.
- C. Float:
  - 1. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.
  - 2. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of Owner and Contractor.
  - 3. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs which (i) impacts Project's critical path, (ii) consumes available float or contingency time, and (iii) extends Work beyond contract completion date.
- D. Claims Based on Contract Times:
  - 1. Where Engineer has not yet rendered formal decision on Contractor's Claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, reflect an interim adjustment in the Progress Schedule as acceptable to Engineer.

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- 2. It is understood and agreed that such interim acceptance will not be binding on either Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.
- 3. Revise Progress Schedule prepared thereafter in accordance with Engineer's formal decision.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION (NOT USED)

### **END OF SECTION**

#### SECTION 01 33 00 SUBMITTAL PROCEDURES

#### PART 1 GENERAL

#### 1.01 DEFINITIONS

- A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval.
- B. Informational Submittal: Information submitted by Contractor that requires Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract.

#### 1.02 PROCEDURES

- A. Direct submittals to Owner at the address specified in the purchasing documents, unless specified otherwise.
- B. Transmittal of Submittal:
  - 1. Contractor shall:
    - a. Review each submittal and check for compliance with Contract Documents.
    - b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
      - Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
      - 2) Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
  - 2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form attached at end of this section.
  - 3. Identify each submittal with the following:
    - Numbering and Tracking System:
      - 1) Sequentially number each submittal.
      - 2) Resubmission of submittal shall have original number with sequential alphabetic suffix.
    - b. Specification section and paragraph to which submittal applies.
    - c. Project title and Engineer's project number.
    - d. Date of transmittal.

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a.

SUBMITTAL PROCEDURES 01 33 00 - 1

- e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
- 4. Identify and describe each deviation or variation from Contract Documents.
- C. Format:
  - 1. Do not base Shop Drawings on reproductions of Contract Documents.
  - 2. Package submittal information by individual Specification section. Do not combine different Specification sections together in submittal package, unless otherwise directed in Specification.
  - 3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
  - 4. Index with labeled tab dividers in orderly manner.
- D. Timeliness: Schedule and submit in accordance Schedule of Submittals and requirements of individual Specification sections.
- E. Processing Time:
  - 1. Time for review shall commence on Engineer's receipt of submittal.
  - 2. Engineer will act upon Contractor's submittal and transmit response to Contractor not later than 30 days after receipt, unless otherwise specified.
  - 3. Resubmittals will be subject to same review time.
  - 4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.
- F. Resubmittals: Clearly identify each correction or change made.
- G. Incomplete Submittals:
  - 1. Engineer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
  - 2. When any of the following are missing, submittal will be deemed incomplete:
    - a. Contractor's review stamp; completed and signed.
    - b. Transmittal of Contractor's Submittal; completed and signed.
    - c. Insufficient number of copies.
- H. Submittals not required by Contract Documents:
  - 1. Will not be reviewed and will be returned stamped "Not Subject to Review."
  - 2. Engineer will keep one copy and return submittal to Contractor.

SUBMITTAL PROCEDURES 01 33 00 - 2

### 1.03 ACTION SUBMITTALS

- A. Prepare and submit Action Submittals required by individual Specification sections.
- B. Shop Drawings:
  - 1. Copies: Six, and one reproducible, except copyrighted documents.
  - 2. Identify and Indicate:
    - a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
    - b. Equipment and Component Title: Identical to title shown on Drawings.
    - c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
    - d. Project-specific information drawn accurately to scale.
  - 3. Manufacturer's standard schematic drawings and diagrams as follows:
    - a. Modify to delete information that is not applicable to the Work.
    - b. Supplement standard information to provide information specifically applicable to the Work.
  - 4. Product Data: Provide as specified in individual Specifications.
  - 5. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.
- C. Samples:
  - 1. Copies: Two, unless otherwise specified in individual Specifications.
  - 2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
    - a. Manufacturer name.
    - b. Model number.
    - c. Material.
    - d. Sample source.
  - 3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
  - 4. Full-size Samples:
    - a. Size as indicated in individual Specification section.
    - b. Prepared from same materials to be used for the Work.
    - c. Cured and finished in manner specified.
    - d. Physically identical with product proposed for use.

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- D. Action Submittal Dispositions: Engineer will review, comment, stamp, and distribute as noted:
  - 1. Approved:
    - a. Contractor may incorporate product(s) or implement Work covered by submittal.
    - b. Distribution:
      - 1) One copy furnished Owner.
      - 2) One copy furnished Resident Project Representative.
      - 3) One copy retained in Engineer's file.
      - 4) Remaining copies returned to Contractor appropriately annotated.
  - 2. Approved as Noted:
    - a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
    - b. Distribution:
      - 1) One copy furnished Owner.
      - 2) One copy furnished Resident Project Representative.
      - 3) One copy retained in Engineer's file.
      - 4) Remaining copies returned to Contractor appropriately annotated.
  - 3. Partial Approval, Resubmit as Noted:
    - a. Make corrections or obtain missing portions, and resubmit.
    - b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
    - c. Distribution:
      - 1) One copy furnished Owner.
      - 2) One copy furnished Resident Project Representative.
      - 3) One copy retained in Engineer's file.
      - 4) Remaining copies returned to Contractor appropriately annotated.
  - 4. Revise and Resubmit:
    - a. Contractor may not incorporate product(s) or implement Work covered by submittal.
    - b. Distribution:
      - 1) One copy furnished Resident Project Representative.
      - 2) One copy retained in Engineer's file.
      - 3) Remaining copies returned to Contractor appropriately annotated.

#### 1.04 INFORMATIONAL SUBMITTALS

#### A. General:

- 1. Copies: Submit three copies, unless otherwise indicated in individual Specification section.
- 2. Refer to individual Specification sections for specific submittal requirements.
- 3. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward copy to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will retain one copy and return remaining copy with review comments to Contractor, and require that submittal be corrected and resubmitted.

#### B. Certificates:

- 1. General:
  - a. Provide notarized statement that includes signature of entity responsible for preparing certification.
  - b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
- 2. Welding: In accordance with individual Specification sections.
- 3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual Specification section.
- 4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
- 5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual Specification sections.
- 6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.
- 7. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers' Field Services.
- C. Construction Photographs: In accordance with Section 01 31 13, Project Coordination, and as may otherwise be required in Contract Documents.
- D. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.
- E. Contractor-design Data (related to temporary construction):
  - 1. Written and graphic information.
  - 2. List of assumptions.

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- 3. List of performance and design criteria.
- 4. Summary of loads or load diagram, if applicable.
- 5. Calculations.
- 6. List of applicable codes and regulations.
- 7. Name and version of software.
- 8. Information requested in individual Specification section.
- F. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual Specification section.
- G. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.
- H. Payment:
  - 1. Application for Payment: In accordance with Section 01 29 00, Payment Procedures.
  - 2. Schedule of Values: In accordance with Section 01 29 00, Payment Procedures.
- I. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.
- J. Schedules:
  - 1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00, Construction Progress Documentation.
    - a. Show for each, at a minimum, the following:
      - 1) Specification section number.
      - 2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
      - 3) Estimated date of submission to Engineer, including reviewing and processing time.
    - b. On a monthly basis, submit updated Schedule of Submittals to Engineer if changes have occurred or resubmittals are required.
  - 2. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.
- K. Special Guarantee: Supplier's written guarantee as required in individual Specification sections.
- L. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.
- M. Submittals Required by Laws, Regulations, and Governing Agencies:
  - 1. Promptly submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
  - 2. Transmit to Engineer for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.
- N. Test, Evaluation, and Inspection Reports:
  - 1. General: Shall contain signature of person responsible for test or report.
  - 2. Factory:
    - a. Identification of product and Specification section, type of inspection or test with referenced standard or code.
    - b. Date of test, Project title and number, and name and signature of authorized person.
    - c. Test results.
    - d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
    - e. Provide interpretation of test results, when requested by Engineer.
    - f. Other items as identified in individual Specification sections.
  - 3. Field:
    - a. As a minimum, include the following:
      - 1) Project title and number.
      - 2) Date and time.
      - 3) Record of temperature and weather conditions.
      - 4) Identification of product and Specification section.
      - 5) Type and location of test, Sample, or inspection, including referenced standard or code.
      - 6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
      - 7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
      - 8) Provide interpretation of test results, when requested by Engineer.
      - 9) Other items as identified in individual Specification sections.
- O. Testing and Startup Data: In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
- P. Training Data: In accordance with Section 01 43 33, Manufacturers' Field Services.

#### SWF BAF IMPROVEMENTS

### 1.05 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
  - 1. Forms: Transmittal of Contractor's Submittal.

## PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

# **END OF SECTION**

Jacobs transmittal of contractor's submittal			
		DATE:	
TO:	ntractor	Submittal No.: New Submittal I Project: Project No.: Specification Section No.:_ (Cover only one section Schedule Date of Submittal	Resubmittal with each transmittal) :
SUBMITTAL TYPE:	Shop Drawing	Sample	Informational

# The following items are hereby submitted:

Number of	Description of Item Submitted	Spec. and	Drawing or	Contains Variation to Contract	
Copies	Copies (Type, Size, Model Number, Etc.) Para. No.		Brochure Number	No	Yes

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By:\_\_\_\_\_

Contractor (Authorized Signature)

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# SECTION 01 42 13 ABBREVIATIONS AND ACRONYMS

# PART 1 GENERAL

# 1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

- A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual specification sections.
- B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.
- C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.
- D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.
- E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.
- F. Copies of standards and specifications of technical societies:
  - 1. Copies of applicable referenced standards have not been bound in these Contract Documents.
  - 2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor's personnel, Subcontractors, Owner, and Engineer.

# 1.02 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers
		Association
4.	AASHTO	American Association of State Highway and
		Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration
		Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and
		Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and
		Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association
34.	BHMA	Builders Hardware Manufacturers' Association

ABBREVIATIONS AND ACRONYMS 01 42 13 - 2

35.	CBM	Certified Ballast Manufacturer
36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America
40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	EIA	Electronic Industries Alliance
47.	EJCDC	Engineers Joint Contract Documents'
		Committee
48.	ETL	Electrical Test Laboratories
49.	FAA	Federal Aviation Administration
50.	FCC	Federal Communications Commission
51.	FDA	Food and Drug Administration
52.	FEMA	Federal Emergency Management Agency
53.	FIPS	Federal Information Processing Standards
54.	FM	FM Global
55.	Fed. Spec.	Federal Specifications (FAA Specifications)
56.	FS	Federal Specifications and Standards
		(Technical Specifications)
57.	GA	Gypsum Association
58.	GANA	Glass Association of North America
59.	HI	Hydraulic Institute
60.	HMI	Hoist Manufacturers' Institute
61.	IBC	International Building Code
62.	ICBO	International Conference of Building Officials
63.	ICC	International Code Council
64.	ICEA	Insulated Cable Engineers' Association
65.	IFC	International Fire Code
66.	IEEE	Institute of Electrical and Electronics Engineers,
		Inc.
67.	IESNA	Illuminating Engineering Society of North
		America
68.	IFI	Industrial Fasteners Institute
69.	IGMA	Insulating Glass Manufacturer's Alliance
70.	IMC	International Mechanical Code
71.	INDA	Association of the Nonwoven Fabrics Industry
72.	IPC	International Plumbing Code
73.	ISA	International Society of Automation
74.	ISO	International Organization for Standardization
75.	ITL	Independent Testing Laboratory

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76.	JIC	Joint Industry Conferences of Hydraulic
		Manufacturers
77.	MIA	Marble Institute of America
78.	MIL	Military Specifications
79.	MMA	Monorail Manufacturers' Association
80.	MSS	Manufacturer's Standardization Society
81.	NAAMM	National Association of Architectural Metal
		Manufacturers
82.	NACE	NACE International
83.	NBGQA	National Building Granite Quarries Association
84.	NEBB	National Environmental Balancing Bureau
85.	NEC	National Electrical Code
86.	NECA	National Electrical Contractor's Association
87.	NEMA	National Electrical Manufacturers' Association
88.	NESC	National Electrical Safety Code
89.	NETA	InterNational Electrical Testing Association
90.	NFPA	National Fire Protection Association
91.	NHLA	National Hardwood Lumber Association
92.	NICET	National Institute for Certification in
		Engineering Technologies
93.	NIST	National Institute of Standards and Technology
94.	NRCA	National Roofing Contractors Association
95.	NRTL	Nationally Recognized Testing Laboratories
96.	NSF	NSF International
97.	NSPE	National Society of Professional Engineers
98.	NTMA	National Terrazzo and Mosaic Association
99.	NWWDA	National Wood Window and Door Association
100.	OSHA	Occupational Safety and Health Act (both
		Federal and State)
101.	PCI	Precast/Prestressed Concrete Institute
102.	PEI	Porcelain Enamel Institute
103.	PPI	Plastic Pipe Institute
104.	PS	Product Standards Section-U.S. Department of
		Commerce
105.	RMA	Rubber Manufacturers' Association
106.	RUS	Rural Utilities Service
107.	SAE	SAE International
108.	SDI	Steel Deck Institute
109.	SDI	Steel Door Institute
110.	SJI	Steel Joist Institute
111.	SMACNA	Sheet Metal and Air Conditioning Contractors
		National Association
112.	SPI	Society of the Plastics Industry
113.	SSPC	The Society for Protective Coatings

ABBREVIATIONS AND ACRONYMS 01 42 13 - 4

114.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
115.	SWI	Steel Window Institute
116.	TEMA	Tubular Exchanger Manufacturers' Association
117.	TCA	Tile Council of North America
118.	TIA	Telecommunications Industry Association
119.	UBC	Uniform Building Code
120.	UFC	Uniform Fire Code
121.	UL	formerly Underwriters Laboratories Inc.
122.	UMC	Uniform Mechanical Code
123.	USBR	U.S. Bureau of Reclamation
124.	WCLIB	West Coast Lumber Inspection Bureau
125.	WI	Wood Institute
126.	WWPA	Western Wood Products Association

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

#### **EXECUTION (NOT USED)** PART 3

#### **END OF SECTION**

# SECTION 01 43 33 MANUFACTURERS' FIELD SERVICES

# PART 1 GENERAL

#### 1.01 DEFINITIONS

A. Person-Day: One person for 8 hours within regular Contractor working hours.

#### 1.02 SUBMITTALS

- A. Informational Submittals:
  - 1. Training Schedule: Submit, in accordance with requirements of this Specification, not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.
  - 2. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
  - 3. Training Session Recordings: Furnish Owner with two complete sets of recordings fully indexed and cataloged with printed label stating session and date recorded.

#### 1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

- A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual Specification section.
- B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

# PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION

#### 3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services, when required by an individual Specification section, to meet the requirements of this section.

- B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.
- C. Schedule manufacturer' services to avoid conflict with other onsite testing or other manufacturers' onsite services.
- D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.
- E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.
- F. When specified in individual Specification sections, manufacturer's onsite services shall include:
  - 1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
  - 2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
  - 3. Providing, on a daily basis, copies of manufacturers' representatives field notes and data to Engineer and Owner.
  - 4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
  - 5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
  - 6. Assistance during functional and performance testing, and facility startup and evaluation.
  - 7. Training of Owner's personnel in the operation and maintenance of respective product as required.

# 3.02 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

- A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.
- B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

# 3.03 TRAINING

- A. General:
  - 1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
  - 2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
  - 3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
  - 4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.
- B. Training Schedule:
  - 1. List specified equipment and systems that require training services and show:
    - a. Respective manufacturer.
    - b. Estimated dates for installation completion.
    - c. Estimated training dates.
  - 2. Allow for multiple sessions when several shifts are involved.
  - 3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
  - 4. Coordinate with Section 01 32 00, Construction Progress Documentation, and Section 01 91 14, Equipment Testing and Facility Startup.
- C. Lesson Plan: When manufacturer or vendor training of Owner personnel is specified, prepare a lesson plan for each required course containing the following minimum information:
  - 1. Title and objectives.
  - 2. Recommended attendees (such as, managers, engineers, operators, maintenance).
  - 3. Course description, outline of course content, and estimated class duration.
  - 4. Format (such as, lecture, self-study, demonstration, hands-on).
  - 5. Instruction materials and equipment requirements.
  - 6. Resumes of instructors providing training.

- D. Prestartup Training:
  - 1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
  - 2. Complete at least 14 days prior to beginning of facility startup.
- E. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives.
- F. Recording of Training Sessions:
  - 1. Furnish audio and color recording of prestartup and post-startup instruction sessions, including manufacturers' representatives' hands-on equipment instruction and classroom sessions.
  - 2. Use DVD format suitable for playback on standard equipment available commercially in the United States. Blu-ray® DVD format is not acceptable without Engineer's prior approval.

# 3.04 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
  - 1. Manufacturer's Certificate of Proper Installation.

# **END OF SECTION**

# **MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION**

OWNER	EQPT SERIAL NO:	
EQPT TAG NO:	EQPT/SYSTEM:	
PROJECT NO:	SPEC. SECTION:	
I hereby certify that the above-referenced equ	ipment/system has been:	
(Check Applicable)		
Installed in accordance with Manufacturer's recommendations.		
Inspected, checked, and adjusted.		
Serviced with proper initial lubricants.		
Electrical and mechanical connections meet quality and safety standards.		
All applicable safety equipment has been properly installed.		
Functional tests.		
System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)		
Note: Attach any performance test documentation from manufacturer.		
Comments:		
I, the undersigned Manufacturer's Representa authorized representative of the manufacturer inspect, approve, and operate their equipment recommendations required to ensure equipme and operational, except as may be otherwise in information contained herein is true and accur	tive, hereby certify that I am (i) a duly , (ii) empowered by the manufacturer to and (iii) authorized to make nt furnished by the manufacturer is complete ndicated herein. I further certify that all rate.	
Date:	_, 20	
Manufacturer:		

By Manufacturer's Authorized Representative:

(Authorized Signature)

# SECTION 01 45 16.13 CONTRACTOR QUALITY CONTROL

# PART 1 GENERAL

# 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
    - b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

#### 1.02 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

#### 1.03 SUBMITTALS

- A. Informational Submittals:
  - 1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
  - 2. CQC Report: Submit, weekly, an original and one copy in report form.

# 1.04 OWNER'S QUALITY ASSURANCE

- A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.
- B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:
  - 1. Relieve Contractor of responsibility for providing adequate quality control measures;
  - 2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance;
  - 3. Constitute or imply acceptance; or
  - 4. Affect the continuing rights of Owner after acceptance of the completed Work.

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- C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.
- D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.
- E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

# PART 2 PRODUCTS (NOT USED)

# PART 3 EXECUTION

- 3.01 GENERAL
  - A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.
  - B. Maintain complete inspection records and make them available at all times to Owner and Engineer.
  - C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

#### 3.02 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.
- B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor's management and control with the Owner's Quality Assurance.
- C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

CONTRACTOR QUALITY CONTROL 01 45 16.13 - 2

# 3.03 QUALITY CONTROL ORGANIZATION

- A. CQC System Manager:
  - 1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
  - 2. CQC System Manager may perform other duties on the Project.
  - 3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
  - 4. CQC System Manager shall report to the Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
  - 5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
  - 6. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.
- B. CQC Staff:
  - 1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Engineer.
  - 2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
  - 3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
  - 4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.
- C. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

#### SWF BAF IMPROVEMENTS

# 3.04 QUALITY CONTROL PHASING

- A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:
  - 1. Preparatory Phase:
    - a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
    - b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
    - c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
    - d. Perform prior to beginning Work on each definable feature of Work:
      - 1) Review applicable Contract Specifications.
      - 2) Review applicable Contract Drawings.
      - 3) Verify that all materials and/or equipment have been tested, submitted, and approved.
      - 4) Verify that provisions have been made to provide required control inspection and testing.
      - 5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
      - 6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
      - 7) Review the appropriate activity hazard analysis to verify safety requirements are met.
      - 8) Review procedures for constructing the Work, including repetitive deficiencies.
      - 9) Document construction tolerances and workmanship standards for that phase of the Work.
      - 10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.
  - 2. Initial Phase:
    - a. Accomplish at the beginning of a definable feature of Work:
      - 1) Notify Owner at least 48 hours in advance of beginning the initial phase.

CONTRACTOR QUALITY CONTROL 01 45 16.13 - 4

- 2) Perform prior to beginning Work on each definable feature of Work:
  - a) Review minutes of the preparatory meeting.
  - b) Check preliminary Work to verify compliance with Contract requirements.
  - c) Verify required control inspection and testing.
  - d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
  - e) Resolve all differences.
  - f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
- Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
- 4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
- 3. Follow-up Phase:
  - a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
  - b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
  - c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
- 4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

#### SWF BAF IMPROVEMENTS

#### 3.05 CONTRACTOR QUALITY CONTROL PLAN

#### A. General:

- 1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
- 2. An interim plan for the first 30 days of operation will be considered.
- 3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
- 4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.
- B. Content:
  - 1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
    - a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
    - b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
    - c. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.
    - d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
    - e. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.

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- f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
- g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
- h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.
- C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.
- D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

# 3.06 CONTRACTOR QUALITY CONTROL REPORT

- A. As a minimum, prepare a CQC report for every 7 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.
- B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.
- C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
  - 1. Contractor/subcontractor and their areas of responsibility.
  - 2. Operating plant/equipment with hours worked, idle, or down for repair.
  - 3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
  - 4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
  - 5. Material received with statement as to its acceptability and storage.
  - 6. Identify submittals reviewed, with Contract reference, by whom, and action taken.

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- 7. Offsite surveillance activities, including actions taken.
- 8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
- 9. List instructions given/received and conflicts in the Drawings and/or Specifications.
- 10. Contractor's verification statement.
- 11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
- 12. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

# 3.07 SUBMITTAL QUALITY CONTROL

A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

# 3.08 TESTING QUALITY CONTROL

- A. Testing Procedure:
  - 1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
    - a. Verify testing procedures comply with contract requirements.
    - b. Verify facilities and testing equipment are available and comply with testing standards.
    - c. Check test instrument calibration data against certified standards.
    - d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
    - e. Documentation:
      - 1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
      - 2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
      - 3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.

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- 4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
- 5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.
- B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

# 3.09 COMPLETION INSPECTION

- A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.
- B. Punchlist:
  - 1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
  - 2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
  - 3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
  - 4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

# END OF SECTION

# SECTION 01 50 00 TEMPORARY FACILITIES AND CONTROLS

# PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Association of Nurserymen (AAN): American Standards for Nursery Stock.
  - 2. Federal Emergency Management Agency (FEMA).
  - 3. National Fire Prevention Association (NFPA): 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
  - 4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
  - 5. U.S. Department of Agriculture (USDA): Urban Hydrology for Small Watersheds.
  - 6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.

# 1.02 SUBMITTALS

- A. Informational Submittals:
  - 1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
  - 2. Temporary Utility Submittals:
    - a. Dewatering well locations.
    - b. Sanitary.
  - 3. Temporary Construction Submittals:
    - a. Access Roads: Routes, cross-sections, and drainage facilities.
    - b. Parking area plans.
    - c. Contractor's field office, storage yard, and storage building plans, including gravel surfaced area.
    - d. Fencing and protective barrier locations and details.
    - e. Engineer's field office plans.
    - f. Staging area location plan.
    - g. Traffic and Pedestrian Control and Routing Plans: As specified herein, and proposed revisions thereto.
    - h. Plan for maintenance of existing plant operations.

- 4. Temporary Control Submittals:
  - a. Noise control plan.
  - b. Dust control plan.
  - c. Plan for disposal of waste materials and intended haul routes.

# 1.03 MOBILIZATION

- A. Mobilization includes, but is not limited to, these principal items:
  - 1. Obtaining required permits.
  - 2. Moving Contractor's field office and equipment required for first month operations onto Site.
  - 3. Installing temporary construction power, wiring, and lighting facilities.
  - 4. Providing onsite Internet service.
  - 5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
  - 6. Arranging for and erection of Contractor's work and storage yard.
  - 7. Posting OSHA required notices and establishing safety programs and procedures.
  - 8. Having Contractor's superintendent at Site full time.
  - 9. Providing Engineer's facilities.
- B. Use area designated for Contractor's temporary facilities as directed by the Owner.

# 1.04 PROTECTION OF WORK AND PROPERTY

- A. Comply with Owner's safety rules while on Owner's property.
- B. Keep Owner informed of serious onsite accidents and related claims.
- C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

#### 1.05 VEHICULAR TRAFFIC

- A. Traffic Control Plan: Adhere to traffic control plan.
- B. Traffic Routing Plan: Show sequences of construction affecting use of roadways, time required for each phase of the Work, provisions for decking over excavations and phasing of operations to provide necessary access, and plans for signing, barricading, and striping to provide passages for pedestrians and vehicles.

# PART 2 PRODUCTS

### 2.01 ENGINEER'S FIELD OFFICES

- A. Furnish equipment specified for exclusive use of Engineer and its' representatives.
- B. Ownership of equipment furnished under this article will remain, unless otherwise specified, that of Contractor.
- C. Equipment furnished shall be new or like new in appearance and function.
- D. Minimum Features:
  - 1. 110-volt lighting and wall plugs.
  - 2. Fluorescent ceiling lights.
  - 3. Electric heating and self-contained air conditioning unit, properly sized for Project locale and conditions. Provide ample electric power to operate installed systems.
  - 4. Covered entrances with railed stairways, landings, and exterior lighting at entrances.
  - 5. Sign on entrance door reading JACOBS, letter height 4 inches minimum.
  - 6. Exterior Door(s):
    - a. Number: One.
    - b. Type: Solid core.
    - c. Lock(s): Cylindrical.
  - 7. Number of Windows: Two.
  - 8. Minimum Interior Height: 8 feet.
- E. Floor Space: Minimum 225 square feet.
- F. Rooms: Two, with minimum private office floor space of 80 square feet, and remainder configured for open meeting or storage space.
- G. Plan table; plan rack; one double desk(s) with desk surface located 29 inches from floor; two 2-drawer, steel file cabinets; and overhead shelf(s).
- H. Office Equipment—General:
  - 1. Bottled Water Service: One, with cooler capable of producing hot water and cold water.
  - 2. Paper Cup Dispenser with Cups: One.
  - 3. Paper Towel Dispenser with Towels: One.
  - 4. Four-Drawer Steel File with Lock: One.
  - 5. Drawing Rack with Drawing Hangers: One.

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- 6. Bookcase: One, 36 inches wide by 48 inches high.
- 7. Wastepaper Basket: Two.
- 8. First-Aid Kit: One.
- 9. Tri-Class (ABC), Dry Chemical Fire Extinguisher, 10-Pound: One.

# PART 3 EXECUTION

#### 3.01 ENGINEER'S FIELD OFFICE

- A. Make available for Engineer's use prior to start of the Work at Site and to remain on Site for minimum of 30 days after final acceptance of the Work.
- B. Locate where directed by Engineer; level, block, tie down, skirt, provide stairways, and relocate when necessary and approved. Construct on proper foundations, and provide proper surface drainage and connections for utility services.
- C. Provide minimum 100 square feet of gravel or crushed rock base, minimum depth of 4 inches, at each entrance.
- D. Raise grade under field office, as necessary, to elevation adequate to avoid flooding.
- E. Provide sanitary facilities in compliance with state and local health authorities.
- F. Exterior Door Keys: Furnish two set(s) of keys.
- G. Maintain in good repair and appearance, and provide weekly cleaning service and replenishment, as required, of paper towels, paper cups, hand soap, toilet paper, first-aid kit supplies, and bottled water.

### 3.02 TEMPORARY UTILITIES

- A. Power:
  - 1. Make arrangements to obtain and pay for electrical power used until final payment and acceptance by Owner, unless otherwise recommended by Engineer at Substantial Completion.
  - 2. Cost of electric power will be borne by Contractor.
- B. Lighting: Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.

- C. Heating, Cooling, and Ventilating:
  - 1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finishes from damage because of temperature or humidity. Costs for temporary heat shall be borne by Contractor responsible for constructing structure or building as specified in Section 01 11 00, Summary of Work.
  - 2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
  - 3. Pay costs of installation, maintenance, operation, removal, and fuel consumed.
  - 4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
  - 5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.
- D. Water: No construction or potable water is available at Site. Make arrangements for and bear costs of providing water required for construction purposes and for drinking by construction personnel during construction.
- E. Sanitary and Personnel Facilities: Provide and maintain facilities for Contractor's employees, Subcontractors, and other onsite employers' employees. Service, clean, and maintain facilities and enclosures.
- F. Telephone Service:
  - 1. Contractor: Arrange and provide onsite telephone service for use during construction. Pay costs of installation and monthly bills.
- G. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

#### 3.03 PROTECTION OF WORK AND PROPERTY

- A. General:
  - 1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.

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- 2. No residence or business shall be cut off from vehicular traffic for a period exceeding 4 hours, unless special arrangements have been made.
- 3. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
- 4. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform work to their satisfaction.
- 5. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
- 6. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
- 7. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
- 8. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
- 9. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
- 10. Maintain original Site drainage wherever possible.
- B. Site Security:
  - 1. Erect a temporary security fence for protection of existing facilities. Maintain fence throughout construction period. Obtain Engineer's written permission before removal of temporary security fencing.
  - 2. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.
- C. Barricades and Lights:
  - 1. Provide as required by the Vehicle Code and in sufficient quantity to safeguard public and the Work.

- 2. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
- 3. Provide to protect existing facilities and adjacent properties from potential damage.
- 4. Locate to enable access by facility operators and property owners.
- 5. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.
- 6. Locate barricades at the nearest intersecting public thoroughfare on each side of blocked section.
- 7. Illuminate barricades and obstructions with warning lights from sunset to sunrise.
- D. Trees and Plantings:
  - 1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on the Drawings to remain undisturbed.
    - a. Where practical, tunnel beneath trees when on or near line of trench.
    - b. Employ hand excavation as necessary to prevent tree injury.
    - c. Do not stockpile materials or permit traffic within drip lines of trees.
    - d. Provide and maintain temporary barricades around trees.
    - e. Water vegetation as necessary to maintain health.
    - f. Cover temporarily exposed roots with wet burlap, and keep burlap moist until soil is replaced around roots.
    - g. No trees, except those specifically shown on the Drawings to be removed, shall be removed without written approval of Engineer.
    - h. Dispose of removed trees in a legal manner off the Site.
  - Balling and burlapping of trees indicated for replacement shall conform to recommended specifications set forth in the American Standards for Nursery Stock, published by American Association of Nurserymen. Balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by ball and not by top.
  - 3. In event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.
  - 4. Replace each plant that dies as a result of construction activities.

- E. Existing Structures:
  - 1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor's operations, obtain approval of property owner and Engineer.
  - 2. Move mailboxes to temporary locations accessible to postal service.
  - 3. Replace items removed in their original location and a condition equal to or better than original.
- F. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.
- G. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.
- H. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.
- I. Endangered and Threatened Species:
  - 1. Take precautions necessary and prudent to protect native endangered and threatened flora and fauna.
  - 2. Notify Engineer of construction activities that might threaten endangered and threatened species or their habitats.
  - 3. Engineer will mark areas known as habitats of endangered and threatened species prior to commencement of onsite activities.
  - 4. Additional areas will be marked by Engineer as other habitats of endangered and threatened species become known during construction.

#### 3.04 TEMPORARY CONTROLS

- A. Air Pollution Control:
  - 1. Minimize air pollution from construction operations.
  - 2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
  - 3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.

- 4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.
- B. Noise Control:
  - 1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
  - 2. Noise Control Ordinance: In accordance with local ordinances.
  - 3. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.
- C. Water Pollution Control:
  - 1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
  - 2. Prior to commencing excavation and construction, obtain Owner's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewatering pump discharges.
  - 3. Comply with Section 01 57 13, Temporary Erosion and Sedimentation Control, for stormwater flow and surface runoff.
  - 4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.
- D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 13, Temporary Erosion and Sedimentation Control, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

# 3.05 STORAGE YARDS AND BUILDINGS

- A. Coordinate requirements with Section 01 61 00, Common Product Requirements.
- B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

- C. Temporary Storage Buildings:
  - 1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
  - 2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
  - 3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.

#### 3.06 PARKING AREAS

- A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.
- B. Provide parking facilities for personnel working on Project. No employee or equipment parking will be permitted on Owner's existing paved areas, except as specifically designated for Contractor's use.

#### 3.07 VEHICULAR TRAFFIC

- A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Ensure the least possible obstruction to traffic and normal commercial pursuits.
- B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.
- C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.
- D. Maintain top of backfilled trenches before they are paved, to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.
- E. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.

#### 3.08 CLEANING DURING CONSTRUCTION

A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.
- B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up and dispose of debris.
- C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least weekly, dispose of such waste materials, debris, and rubbish offsite.
- D. At least weekly, brush sweep entry drive, roadways, and other streets and walkways affected by the Work and where adjacent to the Work.

# **END OF SECTION**

# SECTION 01 57 13 TEMPORARY EROSION AND SEDIMENT CONTROL

# PART 1 GENERAL

## 1.01 SUMMARY

- A. This section covers Work to implement structural and nonstructural Best Management Practices (BMP) to control soil erosion by wind or water and keep eroded sediments and other construction-generated pollutants from moving off project sites. Requirements described in this Specification and shown on the Drawings and are the minimum for project construction sites and conditions.
- B. National Pollutant Discharge Elimination System: Comply with Federal, state, and local laws, rules and regulations, and the National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Discharge Permit or Permits applicable to the project. A copy of the Project's General Construction Permit, if applicable to the Project, is available from Owner. NPDES General Construction permits are required on Projects that involve disturbance of 1 acre or more with potential to discharge stormwater to surface waters.
- C. As shown on the Drawings, the disturbed limits are less than 1 acre and therefore, a NPDES permit for construction from the Florida Department of Environmental Protection (FDEP) and a Stormwater Pollution Prevention Plan are not required.
- D. Contractor is responsible for implementing and maintaining the erosion control materials as shown on the Drawings during construction. Erosion control BMP shown are the minimum required.
- E. Contractor shall take additional measures to preclude erosion sediment and material from leaving the site if the minimum BMPs shown on the Drawings are insufficient. Contractor to submit supplemental erosion control plan if additional erosion control measures are required.
- F. Engineer may require additional temporary control measures if it appears pollution or erosion may result from weather, nature of materials, or progress on the Work.

- G. Install all sediment control devices including, but not limited to, sediment ponds, perimeter silt fencing, or other sediment trapping BMPs prior to any ground disturbing activity. Do not expose more erodible earth than necessary during clearing, grubbing, excavation, borrow, or fill activities without written approval by Engineer. Engineer may increase or decrease the limits based on project conditions. Erodible earth is defined as any surface where soils, grindings, or other materials may be capable of being displaced and transported by rain, wind, or surface water runoff. Cover inactive areas of erodible earth, whether at final grade or not, within specified time period (see [NPDES] Erosion and Sediment Control Permit), using an approved soil covering practice. Phase clearing and grading to maximum extent practical to prevent exposed inactive areas from becoming a source of erosion.
- H. Water Management:
  - 1. Manage site water in accordance with the conditions of the waste discharge permit from a local permitting authority. If site water management is not subject to permit, manage as follows:
    - a. Groundwater: When groundwater is encountered in an excavation, treat and discharge as follows:
      - 1) When groundwater conforms to Water Quality Standards, it may bypass detention and treatment facilities and be routed directly to its normal discharge point at a rate and method that will not cause erosion.
      - 2) When turbidity of groundwater is similar to turbidity of site runoff, groundwater may be treated using same detention and treatment facilities being used to treat the site runoff and then discharged at a rate that will not cause erosion.
      - 3) When groundwater turbidity is greater than turbidity of site runoff, treat ground water separately until turbidity is similar to or better than site runoff, and then it may be combined with site runoff and treated as described above.
    - b. Process Water:
      - Do not discharge high pH process water or wastewater (nonstormwater) that is generated onsite, including water generated during concrete grinding, rubblizing, washout, and hydrodemolition activities, to waters including wetlands. Water may be infiltrated upon approval of Engineer. Offsite disposal of concrete process water is subject to approval of Engineer.
      - 2) Treat all water generated onsite from construction or washing activities that is more turbid than site runoff separately until turbidity is the same or less than site runoff, and then it may be combined with site runoff and treated as described above. Water may be infiltrated upon approval of Engineer.

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- c. Offsite Water: Prior to disruption of normal watercourse, intercept offsite stormwater and pipe it either through or around the Project Site. This water shall not be combined with onsite stormwater. Discharge offsite water at its preconstruction outfall point preventing an increase in erosion below the site. Submit proposed method for performing this Work for Engineer's approval.
- I. Dispersion/Infiltration: Convey water only to dispersion or infiltration areas designated in the TESC Plan or to sites approved by Engineer. Water shall be conveyed to designated dispersion areas at a rate such that, when runoff leaves the area and enters waters, turbidity standards are achieved. Convey water to designated infiltration areas at a rate that does not produce surface runoff.
- J. Pollution Control: Use BMPs to prevent or minimize stormwater exposure to pollutants from spills; vehicle and equipment fueling, maintenance, and storage; other cleaning and maintenance activities; and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery, as well as debris, leftover paints, solvents, and glues from construction operations. Implement the following BMPs when applicable:
  - 1. Written spill prevention and response procedures.
  - 2. Employee training on spill prevention and proper disposal procedures.
  - 3. Spill kits in all vehicles.
  - 4. Regular maintenance schedule for vehicles and machinery.
  - 5. Material delivery and storage controls.
  - 6. Training and signage.
  - 7. Covered storage areas for waste and supplies.
- K. If Engineer orders the Work suspended, continue to control erosion, pollution, and runoff during the shutdown.
- L. Nothing in this section shall relieve Contractor from complying with other Contract requirements.

### PART 2 PRODUCTS (NOT USED)

### PART 3 EXECUTION

- 3.01 PREPARATION
  - A. Mulch: Furnish, haul, and evenly apply at rates indicated and spread on seeded areas within 48 hours after seeding unless otherwise specified.
    - 1. Distribute straw mulch material with an approved mulch spreader that uses forced air to blow mulch material on seeded areas.

- 2. Apply wood strand mulch by hand or by straw blower on seeded areas.
- 3. Cover temporary seed applied outside application windows established in Section 32 92 00, Turf and Grasses, with a mulch containing either Moderate-Term Mulch or Long-Term Mulch, as designated by Engineer.
- 4. Mulch areas not accessible by mulching equipment by approved hand methods.
- B. Outlet Protection: Provide outlet protection to prevent scour at outlets of ponds, pipes, ditches, or other conveyances.
- C. Sediment Control Barriers: Install sediment control barriers in accordance with Drawings or in the areas of clearing, grubbing, earthwork, or drainage prior to starting those activities. Maintain sediment control barriers until soils are stabilized.
- D. Temporary Seeding and Sod: See Section 32 92 00, Turf and Grasses.
- E. Silt (Sediment) Fence:
  - 1. Silt fence shall be installed in accordance with the Drawings.
  - 2. When sediment deposits reach approximately one-third the height of the silt fence, remove and stabilize deposits.
- F. Street Cleaning: Use self-propelled pickup street sweepers whenever required by Engineer to prevent transport of sediment and other debris off Project Site. Provide street sweepers designed and operated to meet air quality standards. Intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

### 3.02 MAINTENANCE

- A. The measures described in this Specification and shown on the Drawings are minimum requirements for anticipated Site conditions. During the construction period, upgrade these measures as needed to comply with all applicable local, state, and federal erosion and sediment control regulations.
- B. Maintain erosion and sediment control BMPs so they properly perform their function until Engineer determines they are no longer needed.
- C. Construction activities must avoid or minimize excavation and creation of bare ground during wet weather.

- D. The intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.
- E. Inspect BMPs on a weekly basis and document the findings of the inspection.
- F. Unless otherwise specified, remove deposits before the depth of accumulated sediment and debris reaches approximately height of BMP. Dispose of debris or contaminated sediment at approved locations. Clean sediments may be stabilized onsite using BMPs as approved by Engineer.
- G. Sediment Fence: Remove trapped sediment before it reaches one-third of the above ground fence height and before fence removal.
- 3.03 OTHER SEDIMENT BARRIERS (SUCH AS BIOBAGS): REMOVE SEDIMENT BEFORE IT REMOVAL
  - A. When Owner or Engineer determines that an erosion control BMP is no longer required, remove BMP and all associated hardware from the Project limits.
  - B. Permanently stabilize all bare and disturbed soil after removal of erosion and sediment control BMPs. Dress sediment deposits remaining after BMPs have been removed to conform to existing grade. Prepare and sod graded area. If installation and use of erosion control BMPs have compacted or otherwise rendered soil inhospitable to plant growth, such as construction entrances, take measures to rehabilitate soil to facilitate plant growth. This may include, but is not limited to, ripping the soil, incorporating soil amendments, or seeding with specified seed.

# **END OF SECTION**

### SECTION 01 61 00 COMMON PRODUCT REQUIREMENTS

# PART 1 GENERAL

### 1.01 DEFINITIONS

- A. Products:
  - 1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
  - 2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
  - 3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

### 1.02 ENVIRONMENTAL REQUIREMENTS

- A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 10 feet above sea level.
- B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 40 degrees F to 110 degrees F.

### 1.03 PREPARATION FOR SHIPMENT

- A. When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.
- B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

- C. Extra Materials, Special Tools, Test Equipment, and Expendables:
  - 1. Furnish as required by individual Specifications.
  - 2. Schedule:
    - a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
    - b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.
  - 3. Packaging and Shipment:
    - a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
    - b. Prominently displayed on each package, the following:
      - 1) Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
      - 2) Applicable equipment description.
      - 3) Quantity of parts in package.
      - 4) Equipment manufacturer.
  - 4. Deliver materials to Site.
  - 5. Notify Owner upon arrival for transfer of materials.
  - 6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.
- D. Request a minimum 7-day advance notice of shipment from manufacturer. Upon receipt of manufacturer's advance notice of shipment, promptly notify Engineer of anticipated date and place of arrival.
- E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.
- 1.04 DELIVERY AND INSPECTION
  - A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.
  - B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.
  - C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

COMMON PRODUCT REQUIREMENTS 01 61 00 - 2

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

### 1.05 HANDLING, STORAGE, AND PROTECTION

- A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, Temporary Facilities and Controls. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.
- B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.
- C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.
- D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.
- E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.
- F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.
- G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.
- H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.
- B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.
- C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.
- D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
- E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.
- F. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.
- G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.
- H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.
- I. Authority Having Jurisdiction (AHJ):
  - 1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.

COMMON PRODUCT REQUIREMENTS 01 61 00 - 4

- 2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.
- J. Equipment Finish:
  - 1. Provide manufacturer's standard finish and color, except where specific color is indicated.
  - 2. If manufacturer has no standard color, provide equipment with finish as approved by Owner.
- K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.
- L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.
- M. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
  - 1. Use or reuse of components and materials without a traceable certification is prohibited.

# 2.02 FABRICATION AND MANUFACTURE

- A. General:
  - 1. Manufacture parts to U.S.A. standard sizes and gauges.
  - 2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
  - 3. Design structural members for anticipated shock and vibratory loads.
  - 4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
  - 5. Modify standard products as necessary to meet performance Specifications.

- B. Lubrication System:
  - 1. Require no more than weekly attention during continuous operation.
  - 2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
  - 3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
  - 4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

### 2.03 SOURCE QUALITY CONTROL

- A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.
- B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).
- C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

# PART 3 EXECUTION

### 3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

# 3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

- A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.
- B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

COMMON PRODUCT REQUIREMENTS 01 61 00 - 6

- C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.
- D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

### 3.03 INSTALLATION

- A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.
- B. No shimming between machined surfaces is allowed.
- C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Repaint painted surfaces that are damaged prior to equipment acceptance.
- E. Do not cut or notch any structural member or building surface without specific approval of Engineer.
- F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.
- G. For material and equipment specifically indicated or specified to be reused in the Work:
  - 1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
  - 2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

### 3.04 FIELD FINISHING

A. In accordance with Section 09 90 00, Painting and Coating and individual Specification sections.

### 3.05 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

### 3.06 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

# 3.07 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
  - 1. Form: Manufacturer's Certificate of Compliance.

# **END OF SECTION**

# MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER:	_ PRODUCT, MATERIAL, OR SERVICE		
PROJECT NAME:	SUBMITTED:		
PROJECT NO:	_		
Comments:			
I hereby certify that the above-referenced p Contract for the named Project will be furn requirements. I further certify that the prod specified and conform in all respects with t quantity shown.	product, material, or service called for by the hished in accordance with all applicable luct, material, or service are of the quality the Contract requirements, and are in the		
Date of Execution:	, 20		
Manufacturer:			
Manufacturer's Authorized Representative	(print):		

(Authorized Signature)

### SECTION 01 77 00 CLOSEOUT PROCEDURES

# PART 1 GENERAL

### 1.01 SUBMITTALS

- A. Informational Submittals:
  - 1. Submit prior to application for final payment.
    - a. Record Documents: As required in General Conditions.
    - b. Approved Shop Drawings and Samples: As required in the General Conditions.
    - c. Special bonds, Special Guarantees, and Service Agreements.
    - d. Consent of Surety to Final Payment: As required in General Conditions.
    - e. Releases or Waivers of Liens and Claims: As required in General Conditions.
    - f. Releases from Agreements.
    - g. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
    - h. Extra Materials: As required by individual Specification sections.

### 1.02 RECORD DOCUMENTS

- A. Quality Assurance:
  - 1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
  - 2. Accuracy of Records:
    - a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
    - b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
  - 3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
  - 4. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

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# PART 2 PRODUCTS (NOT USED)

# PART 3 EXECUTION

#### 3.01 MAINTENANCE OF RECORD DOCUMENTS

- A. General:
  - 1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
  - 2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
  - 3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.
- B. Preservation:
  - 1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
  - 2. Make documents and Samples available at all times for observation by Engineer.
- C. Making Entries on the Drawings:
  - 1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
    - a. Color Coding:
      - 1) Green when showing information deleted from the Drawings.
      - 2) Red when showing information added to the Drawings.
      - 3) Blue and circled in blue to show notes.
  - 2. Date entries.
  - 3. Call attention to entry by "cloud" drawn around area or areas affected.
  - 4. Legibly mark to record actual changes made during construction, including, but not limited to:
    - a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
    - b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
    - c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.

CLOSEOUT PROCEDURES 01 77 00 - 2

- d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
- e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
- 5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
  - a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
  - b. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
  - c. Make identification so descriptive that it may be related reliably to Specifications.

# 3.02 FINAL CLEANING

- A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.
  - 1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner.
  - 2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
  - 3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
  - 4. Clean all windows.
  - 5. Clean and wax wood, vinyl, or painted floors.
  - 6. Broom clean exterior paved driveways and parking areas.
  - 7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
  - 8. Rake clean all other surfaces.
  - 9. Remove snow and ice from access to buildings.
  - 10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
  - 11. Leave water courses, gutters, and ditches open and clean.
- B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

# **END OF SECTION**

# SECTION 01 78 23 OPERATION AND MAINTENANCE DATA

# PART 1 GENERAL

# 1.01 SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

### 1.02 DEFINITIONS

- A. Preliminary Data: Initial and subsequent submissions for Engineer's review.
- B. Final Data: Engineer-accepted data, submitted as specified herein.
- C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

### 1.03 SEQUENCING AND SCHEDULING

- A. Equipment and System Data:
  - 1. Preliminary Data:
    - a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
    - b. Submit prior to shipment date.
  - 2. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to equipment or system field functional testing.
- B. Materials and Finishes Data:
  - 1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
  - 2. Final Data: Submit within 10 days after final inspection.

### 1.04 DATA FORMAT

A. Prepare preliminary and final data in the form of an instructional manual. Prepare final data in data compilation format and on electronic media.

- B. Instructional Manual Format:
  - 1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
  - 2. Size: 8-1/2 inches by 11 inches, minimum.
  - 3. Cover: Identify manual with typed or printed title "OPERATION AND MAINTENANCE DATA" and list:
    - a. Project title.
    - b. Designate applicable system, equipment, material, or finish.
    - c. Identity of separate structure as applicable.
    - d. Identify volume number if more than one volume.
    - e. Identity of general subject matter covered in manual.
    - f. Identity of equipment number and Specification section.
  - 4. Spine:
    - a. Project title.
    - b. Identify volume number if more than one volume.
  - 5. Title Page:
    - a. Contractor name, address, and telephone number.
    - b. Subcontractor, Supplier, installer, or maintenance contractor's name, address, and telephone number, as appropriate.
      - 1) Identify area of responsibility of each.
      - 2) Provide name and telephone number of local source of supply for parts and replacement.
  - 6. Table of Contents:
    - a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
    - b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
  - 7. Paper: 20-pound minimum, white for typed pages.
  - 8. Text: Manufacturer's printed data, or neatly typewritten.
  - 9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
  - 10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.
- C. Data Compilation Format:
  - 1. Compile all Engineer-accepted preliminary O&M data into a hard-copy, hard-bound set.
  - 2. Each set shall consist of the following:
    - a. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.

- b. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE DATA, VOLUME NO. \_\_\_\_OF \_\_\_\_", and list:
  - 1) Project title.
  - 2) Contractor's name, address, and telephone number.
  - 3) If entire volume covers equipment or system provided by one Supplier include the following:
    - a) Identity of general subject matter covered in manual.
    - b) Identity of equipment number and Specification section.
- c. Provide each volume with title page and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
- d. Table of contents neatly typewritten, arranged in a systematic order:
  - 1) Include list of each product, indexed to content of each volume.
  - 2) Designate system or equipment for which it is intended.
  - 3) Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
- e. Section Dividers:
  - 1) Heavy, 80 pound cover weight, tabbed with numbered plastic index tabs.
  - 2) Fly-Leaf:
    - a) For each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment.
    - b) List with Each Product:
      - (1) Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
      - (2) Identify area of responsibility of each.
      - (3) Provide local source of supply for parts and replacement.
    - c) Identity of separate structure as applicable.
- f. Assemble and bind material, as much as possible, in same order as specified in the Contract Documents.
- D. Electronic Media Format:
  - 1. Portable Document Format (PDF):
    - a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.

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- b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.
- c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.

## 1.05 SUBMITTALS

- A. Informational:
  - 1. Data Outline: Submit two copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
  - 2. Preliminary Data:
    - a. Submit three copies for Engineer's review.
    - b. If data meets conditions of the Contract:
      - 1) One copy will be returned to Contractor.
      - 2) One copy will be forwarded to Resident Project Representative.
      - 3) One copy will be retained in Engineer's file.
    - c. If data does not meet conditions of the Contract:
      - 1) All copies will be returned to Contractor with Engineer's comments (on separate document) for revision.
      - 2) Engineer's comments will be retained in Engineer's file.
      - 3) Resubmit three copies revised in accordance with Engineer's comments.
  - 3. Final Data: Submit three copies in format specified herein.

# 1.06 DATA FOR EQUIPMENT AND SYSTEMS

- A. Content For Each Unit (or Common Units) and System:
  - 1. Product Data:
    - a. Include only those sheets that are pertinent to specific product.
    - b. Clearly annotate each sheet to:
      - 1) Identify specific product or part installed.
      - 2) Identify data applicable to installation.
      - 3) Delete references to inapplicable information.
    - c. Function, normal operating characteristics, and limiting conditions.
    - d. Performance curves, engineering data, nameplate data, and tests.
    - e. Complete nomenclature and commercial number of replaceable parts.
    - f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.

- g. Spare parts ordering instructions.
- h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
- 2. As-installed, color-coded piping diagrams.
- 3. Charts of valve tag numbers, with the location and function of each valve.
- 4. Drawings: Supplement product data with the Drawings as necessary to clearly illustrate:
  - a. Format:
    - 1) Provide reinforced, punched, binder tab; bind in with text.
    - 2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
    - 3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
    - 4) Identify Specification section and product on the Drawings and envelopes.
  - b. Relations of component parts of equipment and systems.
  - c. Control and flow diagrams.
  - d. Coordinate Drawings with Project record documents to assure correct illustration of completed installation.
- 5. Instructions and Procedures: Within text, as required to supplement product data.
  - a. Format:
    - 1) Organize in consistent format under separate heading for each different procedure.
    - 2) Provide logical sequence of instructions for each procedure.
    - 3) Provide information sheet for Owner's personnel, including:
      - a) Proper procedures in event of failure.
      - b) Instances that might affect validity of guarantee or Bond.
  - b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
  - c. Operating Procedures:
    - 1) Startup, break-in, routine, and normal operating instructions.
    - 2) Test procedures and results of factory tests where required.
    - 3) Regulation, control, stopping, and emergency instructions.
    - 4) Description of operation sequence by control manufacturer.
    - 5) Shutdown instructions for both short and extended duration.
    - 6) Summer and winter operating instructions, as applicable.
    - 7) Safety precautions.
    - 8) Special operating instructions.
  - d. Maintenance and Overhaul Procedures:
    - 1) Routine maintenance.
    - 2) Guide to troubleshooting.

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- 3) Disassembly, removal, repair, reinstallation, and reassembly.
- 6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.
- B. Content for Each Electric or Electronic Item or System:
  - 1. Description of Unit and Component Parts:
    - a. Function, normal operating characteristics, and limiting conditions.
    - b. Performance curves, engineering data, nameplate data, and tests.
    - c. Complete nomenclature and commercial number of replaceable parts.
    - d. Interconnection wiring diagrams, including control and lighting systems.
  - 2. Circuit Directories of Panelboards:
  - 3. Electrical service.
  - 4. Control requirements and interfaces.
  - 5. Communication requirements and interfaces.
  - 6. List of electrical relay settings, and control and alarm contact settings.
  - 7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
  - 8. As-installed control diagrams by control manufacturer.
  - 9. Operating Procedures:
    - a. Routine and normal operating instructions.
    - b. Startup and shutdown sequences, normal and emergency.
    - c. Safety precautions.
    - d. Special operating instructions.
  - 10. Maintenance Procedures:
    - a. Routine maintenance.
    - b. Guide to troubleshooting.
    - c. Adjustment and checking.
    - d. List of relay settings, control and alarm contact settings.
  - 11. Manufacturer's printed operating and maintenance instructions.
  - 12. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
- C. Maintenance Summary:
  - 1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.

- 2. Format:
  - a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
  - b. Each Maintenance Summary may take as many pages as required.
  - c. Use only 8-1/2-inch by 11-inch size paper.
  - d. Complete using typewriter or electronic printing.
- 3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
- 4. Recommended Spare Parts:
  - a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
  - b. "Unit" is the unit of measure for ordering the part.
  - c. "Quantity" is the number of units recommended.
  - d. "Unit Cost" is the current purchase price.

## 1.07 DATA FOR MATERIALS AND FINISHES

- A. Content for Architectural Products, Applied Materials, and Finishes:
  - 1. Manufacturer's data, giving full information on products:
    - a. Catalog number, size, and composition.
    - b. Color and texture designations.
    - c. Information required for reordering special-manufactured products.
  - 2. Instructions for Care and Maintenance:
    - a. Manufacturer's recommendation for types of cleaning agents and methods.
    - b. Cautions against cleaning agents and methods that are detrimental to product.
    - c. Recommended schedule for cleaning and maintenance.
- B. Content for Moisture Protection and Weather Exposed Products:
  - 1. Manufacturer's data, giving full information on products:
    - a. Applicable standards.
    - b. Chemical composition.
    - c. Details of installation.
  - 2. Instructions for inspection, maintenance, and repair.

#### 1.08 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
  - 1. Forms: Maintenance Summary Form.

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- PART 2 PRODUCTS (NOT USED)
- PART 3 EXECUTION (NOT USED)

**END OF SECTION** 

OPERATION AND MAINTENANCE DATA 01 78 23 - 8

### MAINTENANCE SUMMARY FORM

# PROJECT: CONTRACT NO.:

1. EQUIPMENT ITEM

2. MANUFACTURER

3. EQUIPMENT/TAG NUMBER(S)

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)

5. NAMEPLATE DATA (hp, voltage, speed, etc.)

6. MANUFACTURER'S LOCAL REPRESENTATIVE \_\_\_\_\_

- Name\_\_\_\_\_ Telephone No. \_\_\_\_\_ a.
- b. Address

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

## 8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal	
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.					

# 9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost		
Note: Identify parts provided by this Contract with two astericks						

Note: Identify parts provided by this Contract with two asterisks.

OPERATION AND MAINTENANCE DATA 01 78 23 SUPPLEMENT - 2

# SECTION 01 88 15 ANCHORAGE AND BRACING

# PART 1 GENERAL

### 1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the Florida Building Code, Seventh Edition (2020), for wind, gravity, soil, and operational loads.

### 1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Concrete Institute (ACI) 318-14, Building Code requirements for Structural Drawings.
  - 2. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
  - 3. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
  - 4. International Code Council (ICC): International Building Code (IBC).
  - 5. Florida Building Commission: Florida Building Code, Seventh Edition (2020).
  - 6. Design Criteria noted on General Structural Notes Sheets on the Drawings.

# 1.03 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

# 1.04 DESIGN AND PERFORMANCE REQUIREMENTS

- A. General:
  - 1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Florida.

2. Design anchorage into concrete including embedment in accordance with ACI 318-14; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.

a. Unless otherwise noted, design for cracked concrete condition.

- 3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
- 4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, wind, and operational loading.
- 5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
- 6. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
- 7. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
- 8. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
- 9. Anchor existing equipment as noted on the Drawings.
- 10. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.
- B. Design Loads:
  - 1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
  - 2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on the Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment.
  - 3. Operational:
    - a. For loading supplied by equipment manufacturer for FBC required load cases.
    - b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
    - c. Locate braces to minimize vibration to or movement of structure.

- Generating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.
- 4. Hydraulic: Design of anchorage for mechanical equipment shall include hydrostatic and hydrodynamic loads determined in accordance with Section 15.7 of ASCE 7-10.

### 1.05 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
    - b. Manufacturers' engineered hardware product data.
    - c. Attachment assemblies' drawings; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
    - d. List of existing architectural, mechanical, and electrical equipment or components to be modified in Project requiring Contractordesigned anchorage and bracing in final retrofitted condition.
    - e. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.
- B. Informational Submittals:
  - 1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include FBC and Project-specific criteria as noted on General Structural Notes on the Drawings, in addition to manufacturer's specific criteria used for design; sealed by a civil or structural engineer registered in the State of Florida.
  - 2. Manufacturer's hardware installation requirements.
- C. Deferred Submittals: Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

#### 1.06 SOURCE QUALITY CONTROL

- A. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.
- B. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

### PART 2 PRODUCTS

### 2.01 GENERAL

- A. Design and construct attachments and supports transferring s loads to structure of materials and products suitable for application and in accordance with design criteria shown on the Drawings and nationally recognized standards.
- B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.
- C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.
- D. Do not use powder-actuated fasteners or sleeve anchors for anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 horsepower.

### PART 3 EXECUTION

#### 3.01 GENERAL

- A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.
- B. Design, provide, and install overall anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.
- C. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.
- D. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.
- E. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.

### 3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.

## 3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. In accordance with Section 05 50 00, Metal Fabrications and Section 05 05 19, Post-Installed Anchors.
- B. Provide any other specified, regulatory required, or required repair verification inspection and testing in accordance with Section 01 45 16.13, Contractor Quality Control.

# **END OF SECTION**

## SECTION 01 91 14 EQUIPMENT TESTING AND FACILITY STARTUP

## PART 1 GENERAL

### 1.01 DEFINITIONS

- A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.
- B. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.
- C. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.
- D. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as lake transfer pumps, filters, backwash supply pump, and air scour blower.
- E. Facility Performance Demonstration:
  - 1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
  - 2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

## 1.02 SUBMITTALS

- A. Informational Submittals:
  - 1. Facility Startup and Performance Demonstration Plan.
  - 2. Functional and performance test results.
  - 3. Completed Unit Process Startup Form for each unit process.
  - 4. Completed Facility Performance Demonstration/Certification Form.

### 1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

- A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:
  - 1. Step-by-step instructions for startup of each unit process and the complete facility.
  - 2. Unit Process Startup Form (sample attached), to minimally include the following:
    - a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
    - b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
    - c. Startup requirements for each unit process, including water, power, chemicals, etc.
    - d. Space for evaluation comments.
  - 3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
    - a. Description of unit processes included in the facility startup.
    - b. Sequence of unit process startup to achieve facility startup.
    - c. Description of computerized operations, if any, included in the facility.
    - d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
    - e. Signature spaces for Contractor and Engineer.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

- 3.01 GENERAL
  - A. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.
  - B. Contractor's Testing and Startup Representative:
    - 1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
    - 2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

- C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.
- D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.
- E. Owner will:
  - 1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
  - 2. Operate process units and facility with support of Contractor.
  - 3. Provide labor and materials as required for laboratory analyses.

### 3.02 EQUIPMENT TESTING

- A. Preparation:
  - 1. Complete installation before testing.
  - 2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
  - 3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
  - 4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
    - a. Owner/Project Name.
    - b. Equipment or item tested.
    - c. Date and time of test.
    - d. Type of test performed (Functional or Performance).
    - e. Test method.
    - f. Test conditions.
    - g. Test results.
    - h. Signature spaces for Contractor and Engineer as witness.
  - 5. Cleaning and Checking: Prior to beginning functional testing:
    - a. Calibrate testing equipment in accordance with manufacturer's instructions.
    - b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
    - c. Lubricate equipment in accordance with manufacturer's instructions.
    - d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.

- e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
- f. Check power supply to electric-powered equipment for correct voltage.
- g. Adjust clearances and torque.
- h. Test piping for leaks.
- 6. Ready-to-test determination will be by Engineer based at least on the following:
  - a. Acceptable Operation and Maintenance Data.
  - b. Notification by Contractor of equipment readiness for testing.
  - c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
  - d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
  - e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
  - f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
  - g. Equipment and electrical tagging complete.
  - h. Delivery of all spare parts and special tools.
- B. Functional Testing:
  - 1. Conduct as specified in individual Specification sections.
  - 2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
  - 3. Prepare Equipment Test Report summarizing test method and results.
  - 4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.
- C. Performance Testing:
  - 1. Conduct as specified in individual Specification sections.
  - 2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
  - 3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
  - 4. Type of fluid, gas, or solid for testing shall be as specified.
  - 5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
  - 6. Prepare Equipment Test Report summarizing test method and results.

EQUIPMENT TESTING AND FACILITY STARTUP 01 91 14 - 4 7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

### 3.03 STARTUP OF UNIT PROCESSES

- A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.
- B. Startup sequencing of unit processes shall be in the following order:
  - 1. Air Scour Blower.
  - 2. Backwash Supply Pump.
  - 3. Lake Transfer Pump.
  - 4. Filters.
- C. Make adjustments, repairs, and corrections necessary to complete unit process startup.
- D. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.
- E. Significant Interruption: May include any of the following events:
  - 1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
  - 2. Failure to meet specified functional operation for more than 2 consecutive hours.
  - 3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
  - 4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
  - 5. As determined by Engineer.
- F. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

#### 3.04 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

- B. Demonstrate proper operation of required interfaces within and between individual unit processes.
- C. After facility is operating, complete performance testing of equipment and systems not previously tested.
- D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility, until all unit processes are operable and under control of computer system.
- E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic and computerized operation.

#### 3.05 SUPPLEMENTS

- A. Supplements listed below, following "End of Section," are a part of this Specification:
  - 1. Unit Process Startup Form.
  - 2. Facility Performance Demonstration/Certification Form.

## **END OF SECTION**

# **UNIT PROCESS STARTUP FORM**

OWNER:	PROJECT:
Unit Process Description: (Include de	escription and equipment number of all equipment and devices):
Startup Procedure (Describe procedu opened/closed, order of equipment st	are for sequential startup and evaluation, including valves to be artup, etc.):
Startup Requirements (Water, powe	r, chemicals, etc.):
Evaluation Comments:	

### FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:\_\_\_\_\_ PROJECT:\_\_\_\_\_

Unit Processes Description (List unit processes involved in facility startup):

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor:	Date:	, 20
Engineer:	Date:	, 20
(Authorized Sig	nature)	

## SECTION 03 30 10 STRUCTURAL CONCRETE

## PART 1 GENERAL

#### 1.01 GENERAL

A. Work shall conform to requirements of ACI 301, Specifications for Structural Concrete, unless otherwise specified.

#### 1.02 REFERENCES

- A. In accordance with ACI 301 and the following:
  - 1. American Concrete Institute (ACI):
    - a. 301, Specifications for Structural Concrete.
    - b. 305.1, Specification for Hot Weather Concreting.
    - c. 306.1, Specification for Cold Weather Concreting.
    - d. 308.1, Specification for Curing Concrete.
    - e. SP-66, Detailing Manual.
  - 2. ASTM International (ASTM):
    - a. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
    - b. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
  - 3. Concrete Reinforcing Steel Institute (CRSI):
    - a. Manual of Standard Practice.Placing Reinforcing Bars.
    - b. ANSI/CRSI RB 4.1, CRSI Standard for Supports for Reinforcement Used in Concrete.
  - 4. National Ready Mixed Concrete Association (NRMCA).

#### 1.03 DEFINITIONS

- A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.
- B. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

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- C. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.
- D. Hot Weather: As defined in ACI 305.1.
- E. New Concrete: Concrete less than 60 days old.
- F. Top Bars: Horizontal bars placed such that 12 inches of fresh concrete is cast below in single placement.

#### 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Formwork and Formwork Accessories: Unless otherwise specified, conform to requirements of ACI 301.
    - b. Reinforcing steel prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66 Detailing Manual:
      - 1) Bending lists.
      - 2) Placing drawings.
    - c. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
    - d. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type.
  - 2. Mix Design:
    - a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
    - b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
    - c. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common product Requirements, for the following:
      - 1) Portland cement.
      - 2) Fly ash.
      - 3) Slag cement.
      - 4) Aggregates, including specified class designation for coarse aggregate.
      - 5) Admixtures.
      - 6) Concrete producer has verified compatibility of constituent materials in design mix.

- d. Test Reports:
  - 1) Cement: Chemical analysis report.
  - 2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
  - 3) Aggregates:
    - a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
    - b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
  - 4) Water-Soluble Chloride-Ion Content in Hardened Concrete: One of the following:
    - a) Test report in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
    - b) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
    - c) All of the following:
      - Manufacturer's Certificate of Compliance that each admixture does not intentionally add chlorides and/or that the chloride content of each admixture does not exceed trace amounts.
      - (2) Verification that potable water is used in the concrete mix or test data documenting the chloride content of the water.
      - (3) Letter from the concrete supplier stating that fine and coarse aggregates are from sources that are not known to be susceptible to chlorides in the aggregates.
  - 5) Alkali Aggregate Reactivity: Where required, in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
- e. Product Data:
  - 1) Admixtures: Manufacturer's product data sheets for each admixture used in proposed mix designs.
- 3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
  - a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
  - b. Documentation of embeds that must be at a temperature above freezing prior to placement of concrete.
  - c. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.

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- d. Methods for temperature protection during placement.
- e. Types of covering, insulation, housing, or heating to be provided.
- f. Curing methods to be used during and following protection period.
- g. Use of strength accelerating admixtures.
- h. Methods for verification of in-place strength.
- i. Procedures for measuring and recording concrete temperatures.
- j. Procedures for preventing drying during dry, windy conditions.
- Detailed plan for hot-weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
  - a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
  - b. Use of retarding admixture.
  - c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
  - d. Types of shading and wind protection to be provided.
  - e. Curing methods, including use of evaporation retardant.
  - f. Procedures for measuring and recording concrete temperatures.
  - g. Procedures for preventing drying during dry, windy conditions.
- 5. Concrete repair techniques.
- B. Informational Submittals:
  - 1. Preinstallation Conference minutes.
  - 2. Manufacturer's application instructions for bonding agent and bond breaker.
  - 3. Manufacturer's Certificate of Compliance to specified standards:
    - a. Bonding agent.
    - b. Bond breaker.
    - c. Repair materials.
  - 4. Statement of Qualification:
    - a. Batch Plant: Certification as specified herein.
    - b. Mix designer.
    - c. Installer.
    - d. Testing agency.
  - 5. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
    - a. Waterstop.
    - b. Joint filler and primer.
    - c. Preformed control joint.

- 6. Concrete Delivery Tickets:
  - a. For each batch of concrete before unloading at Site.
  - b. In accordance with ASTM C94/C94M, including Requirement 14.2.1. through Requirement 14.2.10.
  - c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

# 1.05 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
  - 2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
  - 3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
  - 4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
    - a. Where field testing is required of Contractor, 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.
    - b. 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.
- B. Preinstallation Conference:
  - 1. Required Meeting Attendees:
    - a. Contractor, including pumping, placing and finishing, and curing subcontractors.
    - b. Ready-mix producer.
    - c. Admixture representative.
    - d. Testing and sampling personnel.
    - e. Steel Reinforcement Installer
    - f. Engineer or Engineer's designee.
  - 2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.

- 3. Agenda shall include:
  - a. Admixture types, dosage, performance, and redosing at Site.
  - b. Mix designs, test of mixes, and Submittals.
  - c. Placement methods, techniques, equipment, consolidation, and form pressures.
  - d. Slump and placement time to maintain slump.
  - e. Finish, curing, and water retention.
  - f. Steel reinforcement details.
  - g. Protection procedures for weather conditions.
  - h. Other specified requirements requiring coordination.
- 4. Conference minutes as specified in Section 01 31 19, Project Meetings.

### PART 2 PRODUCTS

#### 2.01 FORMWORK

- A. Form Materials:
  - 1. For exposed areas, use hard plastic finished plywood, overlaid waterproof particle board, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
  - 2. For unexposed areas, use new shiplap or plywood.
- B. Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.
- C. Form Ties:
  - 1. Material: Steel.
  - 2. Spreader Inserts:
    - a. Conical or spherical type.
    - b. Design to maintain positive contact with forming material.
    - c. Furnish units that will leave no metal closer than 1-1/2 inches to concrete surface when forms, inserts, and tie ends are removed.
  - 3. Wire ties not permitted.

#### 2.02 CONCRETE

- A. Materials:
  - 1. Cementitious Materials:
    - a. Cement:
      - 1) Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.

- 2) Blended Hydraulic Cement:
  - a) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
  - b) Portland cement used in blended hydraulic cement; conform to requirements of ASTM C150/C150M.
- 3) Furnish from one source.
- b. Supplementary Cementitious Materials (SCM):
  - 1) Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
    - a) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
  - 2) Slag Cement: In accordance with ASTM C989/C989M, Grade 100 or Grade 120.
- 2. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
  - a. Aggregates:
    - 1) In accordance with ASTM C33/C33M, except as modified herein.
      - a) Class Designation: 4S unless otherwise specified.
      - b) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
      - c) Alkali Silica Reactivity: See Article Concrete Mix Design.
    - 2) Fine Aggregates:
      - a) In accordance with ASTM C33/C33M, except as modified herein.
      - b) In the event manufactured sand is included in the mix design, the material shall be from the same source as the coarse aggregate.
      - c) Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
        - Limit material finer than 75-μm (No. 200) sieve to 3 percent mass of total sample.
        - (2) Limit coal and lignite to 0.5 percent.
    - 3) Coarse Aggregate:
      - a) Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
      - b) Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

- 3. Admixtures:
  - a. Characteristics:
    - 1) Compatible with other constituents in mix.
    - 2) Contain at most, only trace amount chlorides in solution.
    - 3) Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
  - b. Air-Entraining Admixture: ASTM C260/C260M.
  - c. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
  - d. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - e. Accelerating Admixture: ASTM C 494/C 494M, Type C.
  - f. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
  - g. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
  - h. Do not use calcium chloride as an admixture.
  - i. Admixtures with no standard, ASTM or other, designation may be used where permitted.
- 4. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.
  - a. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
    - 1) Chloride Content: 1,000 ppm.
    - 2) Sulfate Content as SO<sub>4</sub>: 3,000 ppm.
    - 3) Alkalis as  $(Na_2O + 0.658 K_2O)$ : 600 ppm.
    - 4) Total Solids by Mass: Less than 50,000 ppm.
- B. Concrete Mix Design:
  - 1. General:
    - a. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
    - b. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
    - c. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.
    - d. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in columns, piers, pilasters, and walls.

- e. Use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
- f. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
- g. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.
- h. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials, aggregate packing, and self-consolidating concrete.
- 2. Potential Alkali-Aggregate Reactivity of Concrete:
  - a. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
  - b. Unless otherwise specified, or unless members are assigned to Exposure Class C0, use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction. Option 3) shall not be used with natural pozzolans, or fly ash that has a CaO content more than 18 percent, or for aggregates with expansions greater than or equal to 0.24 percent when tested in accordance with ASTM C1293. Fly ash with an alkali content greater than 4.0 percent shall not be used in option 2) or 3).
    - 1) For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 shall not exceed 0.04 percent at 1 year.
    - 2) For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 shall not exceed 0.10 percent at an age of 16 days. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent at 16 days when tested in accordance with ASTM C1260.

- 3) Alkali content in concrete (LBA), excluding that from supplementary cementitious materials and the pozzolans and slags in blended cements, shall not exceed 4 lb/yd<sup>3</sup> for aggregates with expansions more than or equal to 0.04 percent and less than 0.12 percent or 3 lb/yd<sup>3</sup> for aggregates with expansions greater than or equal to 0.12 percent and less than 0.24 percent. Reactivity shall be determined by testing in accordance with ASTM C1293. Alkali content shall be calculated as follows:
  - a) LBA = (cement content,  $lb/yd^3$ ) × (equivalent alkali content of portland cement in percent/100 percent)
- 3. Proportions:
  - a. Design mix to meet aesthetic, durability, and strength requirements.
  - b. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.
- 4. Slump:
  - Unless otherwise specified, and prior to submitting mix design, select a target slump at the point of delivery for concrete mixtures used for Work. Selected target slump shall not exceed 9 inches. Concrete shall not show visible signs of segregation. The target slump indicated on the submittal shall be used as the basis for acceptance during the Project. Determine the slump by ASTM C143/C143M.
  - b. Slump tolerance shall meet requirements of ACI 117.
- 5. Size of Coarse Aggregate:
  - a. Unless otherwise specified, nominal maximum size of coarse aggregate shall not exceed:
    - 1) Three-fourths of minimum clear spacing between reinforcement.
    - 2) One-fifth of narrowest dimension between sides of forms.
    - 3) One-third of thickness of slabs or toppings.
- 6. Temperature Limits:
  - a. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set, plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
  - b. For mass concrete sections, provide documentation that maximum concrete temperature in structure will not exceed 160 degrees F, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees F.

c. Accelerating admixture may not be used in mass concrete sections unless the thermal control plan specifically addresses the concrete mixtures with the same accelerating admixture, at a dosage equal to or greater than being proposed for the mass concrete.

### 2.03 REINFORCING STEEL

- A. Deformed Steel Reinforcing Bars: ASTM A615/A615M, Grade 60. Welding of reinforcing bars is not permitted.
- B. Fabrication: Follow CRSI Manual of Standard Practice.

### 2.04 ANCILLARY MATERIALS

- A. Bonding Agent:
  - 1. Unless otherwise specified, in accordance with the following:
    - a. ASTM C881/C881M, Type V.
    - b. Two-component, moisture-insensitive, 100 percent solids epoxy.
    - c. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
    - d. Manufacturers and Products:
      - 1) Master Builders Solutions, Shakopee, MN; MasterInject 1500.
      - 2) Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
      - 3) Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
      - 4) Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

#### B. Bond Breaker:

- 1. Nonstaining type, providing positive bond prevention.
- 2. Manufacturers and Products:
  - a. Dayton Superior Corporation, Miamisburg, OH; Sure Lift J6WB.
  - b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.
- C. Reinforcing Steel Accessories:
  - 1. Plastic Protected Wire Bar Supports: In compliance with ANSI/CRSI RB 4.1 Class 1 Reinforcement Supports.
  - 2. Stainless Steel Protected Wire Bar Supports: In compliance with ANSI/CRSI RB 4.1 Class 2 Reinforcement Supports, except legs shall be made wholly from stainless steel wire.

- Precast Concrete Bar Supports: In compliance with ANSI/CRSI RB
  4.1 Cementitious (Precast) Reinforcement Supports.
  - a. Precast concrete bar supports shall have equal or greater strength than the surrounding concrete.
  - b. Precast concrete bar supports shall be 4 square inches minimum, in plan.
  - c. Precast concrete bar supports shall have tie wires.
- D. Tie Wire:
  - 1. Black, soft-annealed 16-gauge wire.
  - 2. Nylon-coated, epoxy-coated, or plastic-coated wire.
- E. Hydrophilic Waterstop:
  - 1. For use at construction joints only, where new concrete is placed against existing concrete and as shown on the Drawings.
  - 2. Material shall be a nonbentonite hydrophilic rubber compound.
  - 3. Manufacturers and Products:
    - a. Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
    - b. Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.
- F. Premolded Joint Filler:
  - 1. Bituminous Type: ASTM D994/D994M or ASTM D1751.
  - 2. Sponge Rubber:
    - a. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum.
    - b. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK515IHD.
- G. Curing Compound:
  - 1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.
  - 2. Manufacturers and Products:
    - a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
    - b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
    - c. Vexcon Chemical, Inc., Philadelphia, PA; Starseal 1315.
    - d. Dayton Superior; Safe Cure and Seal 1315 EF.

- H. Evaporation Retardant:
  - 1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
  - 2. Manufacturers and Products:
    - a. Master Builders Solutions, Shakopee, MN; MasterKure ER 50.
    - b. Euclid Chemical Co., Cleveland, OH; Eucobar.
- I. Nonshrink Grout:
  - 1. Nonmetallic, nongas-liberating.
  - 2. Prepackaged natural aggregate grout requiring only the addition of water.
  - 3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
  - 4. Test in accordance with ASTM C1107/C1107M:
    - a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
    - b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
  - 5. Pass fluid grout through flow cone with continuous flow 1 hour after mixing.
  - 6. Minimum Strength of Fluid Grout:
    - a. 3,500 psi at 1 day.
    - b. 4,500 psi at 3 days.
    - c. 7,500 psi at 28 days.
  - 7. Maintain fluid consistency when mixed in 1 yard to 9 yard loads in ready-mix truck.
  - 8. Manufacturers and Products:
    - a. Master Builders Solutions, Shakopee, MN; MasterFlow 928.
    - b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
    - c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
    - d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.
- J. Repair Material:
  - 1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
  - 2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
  - 3. Obtain Manufacturer's Certificate of Compliance that products selected are appropriate for specific applications.
  - 4. Repair mortar shall be Site mixed.

- 5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
- 6. Manufacturers and Products:
  - a. Master Builders Solutions, Shakopee, MN; MasterEmaco S Series products.
  - b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop Series.

#### K. Crack Repair:

- 1. Obtain Letter of Certification from manufacturer's technical representative, that products selected are appropriate for the specific applications.
- 2. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
- 3. Use part epoxy injection resin for structural crack repairs.
  - a. Manufacturers:
    - 1) Master Builders Solutions, Shakopee, MN; MasterInject Series.
    - 2) Euclid Chemical Co., Cleveland, OH.; Euco Series (#452).
    - 3) Sika Chemical Corp., Lyndhurst, NJ.; Sikadur Series.

#### 2.05 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Engineer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and subcontractors, providing products included in this section.

## PART 3 EXECUTION

#### 3.01 FORMWORK

- A. Form Construction:
  - 1. Construct forms and provide smooth-form finish.
  - 2. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
  - 3. Make joints tight to prevent escape of mortar and to avoid formation of fins.
  - 4. Brace as required to prevent distortion during concrete placement.
  - 5. On exposed surfaces, locate form ties in uniform pattern or as shown.
  - 6. Construct so ties remain embedded in the member with no metal within 1 inch of concrete surface when forms, inserts, and tie ends are removed.

# B. Form Removal:

- 1. Nonsupporting forms (walls and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
  - a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
  - b. Curing and protection operations are maintained.
- 2. Remove forms with care to prevent scarring and damaging the surface.
- 3. Prior to form removal, provide thermal protection for concrete being placed under the requirements of cold weather concreting.

## 3.02 PLACING REINFORCING STEEL

- A. Unless otherwise specified, in accordance with ACI 301.
- B. Accessories:
  - 1. Bar Supports in Contact with Ground: Provide precast concrete block supports.
    - a. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.
  - 2. Bar Supports in Contact with Forms: Unless otherwise noted, bar supports shall be plastic protected wire bar supports, stainless steel protected wire bar supports, or precast concrete block bar supports.
    - a. Use stainless steel protected wire bar supports or precast concrete block bar supports at formed surfaces that will receive abrasive blasting, hydro-blasting, or grinding.
  - 3. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports, and location of reinforcement remains within tolerance throughout work.
- C. Splices and Laps:
  - 1. Lap Splice Reinforcing: Refer to Structural General Notes on the Drawings for additional information.
  - 2. Tie splices with 16-gauge annealed wire as specified in CRSI Standard.

#### 3.03 INSTALLATION OF WATERSTOPS

#### A. General:

- 1. Continuous waterstop, as specified, shall be installed in construction joints where noted on the Drawings.
- 2. Join waterstop at intersections to provide continuous seal.
- 3. Center waterstop on joint.
- 4. Secure waterstop in correct position. Do not displace waterstop during concrete placement.
- 5. Repair or replace damaged waterstop.
- 6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
- 7. Hydrophilic Waterstop:
  - a. Prepare concrete surfaces and install in accordance with waterstop manufacturer's written instructions and the following:
    - 1) Surface Preparation:
      - a) Concrete surface must be smooth, clean, and dry. Grind concrete as required.
      - b) Clean debris, dirt, dust, and foreign material from concrete surface.
    - 2) Installation:
      - a) Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.
      - b) Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
      - c) Lap ends of waterstop strip together at splices and corners and join with sealant.
      - d) Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.

#### 3.04 CONCRETE PLACEMENT INTO FORMWORK

- A. Inspection: Notify Engineer and Special Inspector at least 1 work day in advance before starting to place concrete.
- B. Placement into Formwork:
  - 1. Reinforcement: Secure in position before placing concrete.
  - 2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs that shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.

- 3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
- 4. Use placement devices (such as, chutes, pouring spouts, and pumps) as required to prevent segregation.
- 5. Vertical Free Fall Drop to Final Placement:
  - a. Forms 8 Inches or Less Wide: 5 feet.
  - b. Forms Wider than 8 Inches: 8 feet, except as specified.
- 6. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
  - a. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
- 7. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
- 8. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
- C. Conveyor Belts and Chutes:
  - 1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
  - 2. Do not use chutes longer than 50 feet.
  - 3. Wipe clean with device that does not allow mortar to adhere to belt.
  - 4. Cover conveyor belts and chutes.
- D. Retempering: Not permitted for concrete where cement has partially hydrated.
- E. Pumping of Concrete:
  - 1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
  - 2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
  - 3. Replace pumping equipment and hoses (conduits) that are not functioning properly.
- F. Maximum Size of Concrete Placements:
  - 1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
  - 2. Locate expansion, control, and contraction, joints where shown.

- G. Minimum Time between Adjacent Placements:
  - 1. Typical Unless Noted Otherwise: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
  - 2. Expansion or Contraction Joints: 1 day.

#### 3.05 CONSOLIDATION AND VISUAL OBSERVATION

A. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.

#### 3.06 COLD WEATHER PLACEMENT

- A. Unless otherwise permitted, shall be in accordance with requirements of ACI 301, ACI 306.1, and as follows:
  - 1. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
  - 2. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.
  - 3. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
  - 4. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
  - 5. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
  - 6. Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.
- B. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.
- C. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.
- D. Cure as specified.

# 3.07 HOT WEATHER PLACEMENT

- A. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
  - 1. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
  - 2. Internal concrete temperature in structure shall not exceed 158 degrees F, and maximum temperature differential between center of section and external surfaces of concrete shall not exceed 35 degrees F.
  - 3. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
  - 4. Cure as specified.

### 3.08 CONCRETE BONDING

- A. Construction Joints at Existing Concrete:
  - 1. Thoroughly clean and roughen existing concrete surfaces to roughness profile of 1/4 inch.
  - 2. Saturate surface with water for 24 hours prior to placing new concrete.

#### 3.09 PREMOLDED JOINT FILLER INSTALLATION

- A. Sufficient in width to completely fill joint space where shown.
- B. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.
- C. Secure premolded joint filler in forms before concrete is placed.

#### 3.10 FINISHING FORMED SURFACES

- A. Provide surface finish 2.0 (SF-2.0) in accordance with ACI 301 and as herein specified.
- B. Tie Holes: Unless otherwise specified, fill with specified repair material.
- C. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.

- D. Repair defective areas of concrete:
  - 1. Cut edges perpendicular to surface at least 1/2 inch deep. Do not feather edges. Soak area with water for 24 hours.
  - 2. Patch with specified repair material.
  - 3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Engineer prior to use.
  - 4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.
  - 5. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
  - 6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.
- E. Crack Injection: When crack repair is deemed by Engineer as requiring a structural repair, use part epoxy injection resin.

### 3.11 FINISHING UNFORMED SURFACES

- A. General:
  - 1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
  - 2. Do not use "jitterbugs" or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
  - 3. Do not dust surfaces with dry materials nor add water to surfaces.
  - 4. Cure concrete as specified.
- B. Slab Tolerances:
  - 1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
  - 2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
  - 3. Steel gauge block 5/16 inch thick.

- 4. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
- 5. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.
- C. Interior Slab Finish: Provide trowel finish unless specified otherwise.
- D. Exterior Slab Finish:
  - 1. Provide broom finish unless specified otherwise.
  - 2. Finish exposed edges with steel edging tool.
  - 3. Mark sidewalks transversely at 5-foot intervals with jointing tool.

#### 3.12 EXPOSED METAL OBJECTS

- A. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
- B. Repair area of chipped-out concrete as specified for defective areas.

### 3.13 BLOCKOUTS AT PIPES OR OTHER PENETRATIONS

A. Where shown, install in accordance with requirements of the Drawings.

#### 3.14 PROTECTION AND CURING

- A. Protect and cure concrete in accordance with requirements of ACI 301, ACI 308.1, and as follows:
  - 1. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.
  - 2. Keep concrete slabs continuously wet for a 7-day period. Intermittent wetting is not acceptable.
  - 3. Use curing compound only where approved by Engineer.
  - 4. Cure formed surfaces with curing compound applied in accordance with manufacturer's written instructions as soon as forms are removed and finishing is completed.
  - 5. Remove and replace concrete damaged by freezing.
  - 6. Repair areas damaged by construction, using specified repair materials and approved repair methods.

#### 3.15 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's written instructions.

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- B. Grouting Machinery Foundations:
  - 1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.
  - 2. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.
  - 3. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.
  - 4. Form with watertight forms at least 2 inches higher than bottom of plate.
  - 5. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's written instructions.

#### 3.16 BACKFILL AGAINST STRUCTURES

- A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.
- B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.
- C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

#### 3.17 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. General:
  - 1. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.
  - 2. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours and for additional time as may be required before transporting to test lab.
  - 3. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
  - 4. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
    - a. For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
  - 5. Evaluation will be in accordance with ACI 301 and Specifications.

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- 6. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
- 7. Frequency of testing may be changed at discretion of Engineer.
- 8. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.
- 9. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.
- B. Concrete Strength Test:
  - 1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
  - 2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
  - 3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.
  - 4. Segregation Test Objective: Concrete shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
  - 5. Test Procedure: Make slump test and check for excessive slump. Observe to see if mortar or moisture flows from slumped concrete.
  - 6. Reject concrete if mortar or moisture separates and flows out of mix.
- C. Cold Weather Placement Tests:
  - 1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
    - a. Six extra test cylinders from last 100 cubic yards of concrete.
    - b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
  - 2. These specimens shall be in addition to those cast for lab testing.
  - 3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
  - 4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.

- 5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
- 6. Use test results to determine specified strength gain prior to falsework removal.
- D. Slab Finish Tolerances and Slope Tolerances:
  - 1. Support 10-foot-long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
  - 2. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

### 3.18 MANUFACTURER'S SERVICES

- A. Provide representative at Site for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.
- B. Concrete Producer Representative:
  - 1. Observe how concrete mixes are performing.
  - 2. Be present during first placement of each type of concrete mix.
  - 3. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
  - 4. Establish control limits on concrete mix designs.
  - 5. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump, and air content when specified.
- C. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
- D. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

#### 3.19 SUPPLEMENTS

- A. Requirements of concrete mix designs following "End of Section," are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:
  - 1. Concrete Mix Design, Class 5000F0S1W0C1.
  - 2. Concrete Mix Design, Class 3000F0S0W0C1.
  - 3. Concrete Mix Design, Class 4000F0S1W0C0.

### **END OF SECTION**
# CONCRETE MIX DESIGN, CLASS 5000F0S1W0C1

- A. Mix Locations: Typical concrete unless noted otherwise.
- B. Exposure Categories and Classifications: F0S1W0C1.
- C. Mix Properties:
  - 1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
  - 2. Minimum concrete compressive strength (f'c) shall be 5,000 psi at 28 days.
    - a. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for slabs to receive a hard-troweled finish.
  - 3. Provide cementitious materials in accordance with one of the following:
    - a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
    - b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      - 1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      - 2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
      - 3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
  - 4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
    - a. Regardless of assigned C Exposure Class, for prestressed and post-tensioned concrete: 0.06 percent.
    - b. Limits are stated in terms of chloride ions in percent by weight of cement.
    - c. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
- D. Refer to PART 1 through PART 3 of this section for additional requirements.

# CONCRETE MIX DESIGN, CLASS 3000F0S0W0C1

- A. Mix Locations:
  - 1. Electrical duct banks.
  - 2. Pipe encasements that are not cast monolithically with concrete base mats or slabs.
  - 3. Where specified in Contract Documents.
- B. Exposure Categories and Classifications: F0S0W0C1.
- C. Mix Properties:
  - 1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.50.
  - 2. Minimum concrete compressive strength (f'c) shall be 3,000 psi at 28 days.
  - 3. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
    - a. Slabs to receive hard-troweled finish.
  - 4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:
  - 5. Provide cementitious materials in accordance with one of the following:
    - a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
    - b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      - 1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      - 2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
      - ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
        - a) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
  - 6. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
    - a. Limits are stated in terms of chloride ions in percent by weight of cement.

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- b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
- D. Refer to PART 1 through PART 3 of this section for additional requirements.

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# CONCRETE MIX DESIGN, CLASS 4000F0S1W0C0

- A. Mix Locations: Concrete curbs and sidewalks.
- B. Exposure Categories and Classifications: F0S1W0C0.
- C. Mix Properties:
  - 1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.50.
  - 2. Minimum concrete compressive strength (f'c) shall be 4,000 psi at 28 days.
  - 3. There are no restrictions on air content except that air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
    - a. Slabs to receive hard-troweled finish.
    - b. Slabs to receive dry shake floor hardener.
    - c. Slabs to receive topping placed monolithically as two-course floor on top of plastic concrete.
  - 4. Provide cementitious materials in accordance with one of the following:
    - a. ASTM C150/C150M Type II.
    - b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      - 1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      - 2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
    - c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
      - 1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
  - 5. Limit water-soluble, chloride-ion content in hardened concrete to 1 percent, unless otherwise specified.
    - a. Limits are stated in terms of chloride ions in percent by weight of cement.
    - b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
- D. Refer to PART 1 through PART 3 of this section for additional requirements.

# SECTION 03 63 00 CONCRETE DOWELING

# PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
  - 1. American National Standards Institute (ANSI).
  - 2. ASTM International (ASTM):
    - a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
    - b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
  - 3. Florida Building Commission: Florida Building Code (FBC) Seventh Edition (2020)
  - 4. International Code Council (ICC):
    - a. 2018 International Building Code (IBC).
    - b. Evaluation Services Reports.
  - 5. NSF International (NSF): 61, Drinking Water System Components Health Effects.

### 1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

### 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Product Data: Manufacturer's catalog information.
- B. Informational Submittals:
  - 1. Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
  - 2. Manufacturer's written letter of certification identifying installer's qualifications to install products.
  - 3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.
  - 4. Field Test Reports: Reports documenting ratio checks made for metering and mixing devices where a batch process is used for mixing adhesive.

### SWF BAF IMPROVEMENTS

### 1.04 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Manufacturer: At least three similar projects with same products within last 3 years.
  - 2. Installer: Trained and certified by manufacturer.
- B. Regulatory Requirements: Adhesive shall be certified as meeting NSF 61 for use in potable water structures.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- B. Store adhesive components in accordance with manufacturer's written instructions.
- C. Dispose of when:
  - 1. Shelf life has expired.
  - 2. Stored other than per manufacturer's instructions.

### PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Adhesive:
  - 1. Approved by an ICC Evaluation Services Report for conformance to 2018 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
  - 2. Suitable for long-term loads as well as for wind loads.
  - 3. Meet requirements of ASTM C881/C881M.
  - 4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
  - 5. Disposable, Self-Contained Cartridge System:
    - a. Capable of dispensing both components in proper mixing ratio.
    - b. Fit into manually or pneumatically operated caulking gun.
  - 6. Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout.
  - 7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.

- 8. Manufacturers and Products:
  - a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD (ESR-2322) or HIT-HY 200 (ESR-3187) Adhesive Anchors.
  - b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System (ESR-3298).
  - c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508).
- B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
- C. Reinforcing Dowels: As specified in Section 03 30 10, Structural Concrete.

# PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Drilling Equipment:
  - 1. Drilling Hammers for Dowel Holes:
    - a. Electric or pneumatic rotary type with medium or light impact.
    - b. Hollow drills with flushing air systems are preferred.
  - 2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.
- C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.
- D. Doweling:
  - 1. Install per details shown on the Drawings and in accordance with adhesive manufacturer's instructions.
  - 2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
  - 3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.

- E. Adhesive:
  - 1. Install in accordance with written manufacturer's instructions.
  - 2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

# 3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

### **END OF SECTION**

## SECTION 05 05 19 POST-INSTALLED ANCHORS

# PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Concrete Institute (ACI):
    - a. 318, Building Code Requirements for Structural Concrete.
    - b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
    - c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
  - 2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
  - 3. American National Standards Institute (ANSI).
  - 4. ASTM International (ASTM):
    - a. A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    - b. A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
    - c. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
    - d. A380, Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
    - e. A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
    - f. A563, Specification for Carbon and Alloy Steel Nuts.
    - g. A967, Specification for Chemical Passivation Treatments for Stainless Steel Parts.
    - h. E488, Standard Test Methods for Strength of Anchors in Concrete Elements.
    - i. F436, Specification for Hardened Steel Washers.
    - j. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
    - k. F568M, Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.
    - 1. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
    - m. F594, Specification for Stainless Steel Nuts.
    - n. F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

- 5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.
- 6. International Code Council Evaluation Service (ICC-ES):
  - a. Evaluation Reports for Concrete and Masonry Anchors.
  - b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
  - c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
  - d. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
  - e. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
  - f. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
- 7. NSF International (NSF): 61, Drinking Water System Components Health Effects.
- 8. Specialty Steel Industry of North America (SSINA):
  - a. Specifications for Stainless Steel.
  - b. Design Guidelines for the Selection and Use of Stainless Steel.
  - c. Stainless Steel Fabrication.
  - d. Stainless Steel Fasteners.

# 1.02 DEFINITIONS

- A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.
- B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.
- C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.
- D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

# 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.
- B. Informational Submittals:
  - 1. Concrete and Masonry Anchors:
    - a. Manufacturer's product description and installation instructions.
    - b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
    - c. Adhesive Anchor Installer Certification.
  - 2. Passivation method for stainless steel members.

# 1.04 QUALITY ASSURANCE

A. Qualifications: Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.

# 1.05 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

# PART 2 PRODUCTS

# 2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

B. Bolts, Washers, and Nuts: Use stainless steel material types as indicated in Fastener Schedule at end of this section.

### 2.02 POST-INSTALLED CONCRETE ANCHORS

- A. General:
  - 1. AISI Type 316 stainless as shown in Fastener Schedule at end of this section.
  - 2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
  - 3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
  - 4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.
  - 5. Acceptable for use in potable water structures by EPA and local health agencies or NSF 61.
- B. Torque-Controlled Expansion Anchors (Wedge Anchors):
  - 1. Manufacturers and Products:
    - a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
    - b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1, +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
    - c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).
- C. Self-Tapping Concrete Screw Anchors:
  - 1. Manufacturers and Products:
    - a. DeWalt/Powers Fasteners, Brewster, NY; Wedge-Bolt+ (ESR-2526).
    - b. DeWalt/Powers Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR-2989).
    - c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
    - d. Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
    - e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713).

- D. Adhesive Anchors:
  - 1. Threaded Rod:
    - a. Diameter as shown on the Drawings.
    - b. Length as required to provide minimum depth of embedment indicated and thread projection required.
    - c. Clean and free of grease, oil, or other deleterious material.
  - 2. Adhesive:
    - a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
    - b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
  - 3. Packaging and Storage:
    - a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
    - b. Store adhesive on pallets or shelving in a covered storage area.
    - c. Package Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
    - d. Dispose of When:
      - 1) Shelf life has expired.
      - 2) Stored other than in accordance with manufacturer's instructions.
  - 4. Manufacturers and Products:
    - a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814), or HIT-HY 200 (ESR-3187).
    - b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508), or AT-XP Adhesive Anchors (IAPMO UES-263).
    - c. DeWalt/Powers Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR-3298).
- E. Adhesive Threaded Inserts:
  - 1. Type 316 stainless steel, internally threaded inserts.
  - 2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-V3 or HIT-HY 200 adhesive.

### 2.03 POST-INSTALLED MASONRY ANCHORS

- A. General: AISI Type 316 stainless as shown in Fastener Schedule at end of section.
- B. Current ICC Evaluation Report indicating acceptance for anchors at structural applications in masonry.

- C. Manufacturers and Products:
  - 1. Hilti, Inc., Tulsa, OK; Kwik-Bolt-3 (KB-3) (ESR-1385), for grout-filled masonry, HIT-HY 70 (ESR-2682) for grout filled CMU, hollow CMU, or unreinforced masonry.
  - Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 (IAPMO ER 240) for grout filled CMU, Titen-HD (ESR-1056) for grout filled or hollow CMU, AT-XP (IAPMO ER-281) for grout filled CMU.
  - 3. DeWalt/Powers Fasteners, Brewster NY; Power-Stud+ SD1 (ESR-2966) for grout-filled masonry, Wedgebolt+ (ESR-1678) for grout-filled masonry.

### PART 3 EXECUTION

### 3.01 CONCRETE AND MASONRY ANCHORS

- A. Begin installation only after concrete or masonry to receive anchors has attained design strength.
- B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.
- C. Install in accordance with written manufacturer's instructions.
- D. Provide minimum embedment, edge distance, and spacing as indicated on the Drawings.
- E. Use only drill type and bit type and diameter recommended by anchor manufacturer.
- F. Clean hole of debris and dust per manufacturer's requirements.
- G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.
- H. Adhesive Anchors:
  - 1. Unless otherwise approved by Engineer and adhesive manufacturer:
    - a. Do not install adhesive anchors when temperature of concrete or masonry is below 40 degrees F or above 100 degrees F.
    - b. Do not install prior to concrete attaining an age of 21 days.
    - c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.

POST-INSTALLED ANCHORS 05 05 19 - 6

- d. Do not disturb anchor during recommended curing time.
- e. Do not exceed maximum torque as specified in manufacturer's instructions.
- 2. For hollow-unit masonry, install screen tube in accordance with manufacturer's instructions.
- I. Prestressed Concrete: Do not use drilled-in anchors in prestressed or posttensioned concrete members without Engineer's prior approval unless specifically shown on the Drawings.

# 3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

# 3.03 MANUFACTURER'S SERVICES

A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Engineer of time and place for sessions.

# 3.04 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
<ol> <li>Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)</li> </ol>		
Interior Dry Areas	Stainless steel anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application

Service Use and Location	Product	Remarks
2. Anchors in Grout-H	Filled Concrete Masonry U	Inits
Interior Dry Areas	Stainless steel anchors	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	
3. Anchors in Hollow Concrete Masonry Units		
Interior Dry Areas	Stainless steel anchors	Adhesive anchors shall be installed with screen tubes
Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	Adhesive anchors shall be installed with screen tubes
4. All Others		
All service uses and locations	Stainless steel fasteners	

- B. Antiseizing Lubricant: Use on all stainless steel threads.
- C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

# END OF SECTION

# SECTION 05 50 00 METAL FABRICATIONS

# PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
  - 2. American Iron and Steel Institute (AISI): Stainless Steel Types.
  - 3. American National Standards Institute (ANSI).
  - 4. American Welding Society (AWS):
    - a. D1.1/D1.1M, Structural Welding Code Steel.
    - b. D1.2/D1.2M, Structural Welding Code Aluminum.
    - c. D1.6/D1.6M, Structural Welding Code Stainless Steel.
  - 5. ASTM International (ASTM):
    - a. A36/A36M, Standard Specification for Carbon Structural Steel.
    - b. A48/A48M, Specification for Gray Iron Castings.
    - c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    - d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
    - e. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    - f. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
    - g. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
    - h. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    - i. A276, Standard Specification for Stainless Steel Bars and Shapes.
    - j. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
    - k. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
    - 1. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
    - m. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
    - n. A489, Standard Specification for Carbon Steel Lifting Eyes.

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- o. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- p. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- q. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- r. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
- s. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
- t. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
- u. A992/A992M, Standard Specification for Structural Steel Shapes.
- v. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
- w. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- x. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- y. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- z. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
- aa. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- bb. D1056, Standard Specification for Flexible Cellular Materials -Sponge or Expanded Rubber.
- cc. F436, Standard Specification for Hardened Steel Washers.
- dd. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
- ee. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- ff. F594, Standard Specification for Stainless Steel Nuts.
- gg. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- hh. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- 6. NSF International (NSF): 61, Drinking Water System Components— Health Effects.
- 7. Specialty Steel Industry of North America (SSINA):
  - a. Specifications for Stainless Steel.
  - b. Design Guidelines for the Selection and Use of Stainless Steel.
  - c. Stainless Steel Fabrication.
  - d. Stainless Steel Fasteners.

METAL FABRICATIONS 05 50 00 - 2

# 1.02 DEFINITIONS

- A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.
- B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals. Corrosive area includes areas exposed to corrosive atmosphere such as hydrogen sulfide from wastewater.
- C. Exterior Area: Location not protected from weather by building or other enclosed structure.
- D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.
- E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

### 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings: Metal fabrications, including welding and fastener information.
- B. Informational Submittals: Passivation method for stainless steel members.

# 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.
- B. Package stainless steel items to provide protection from carbon impregnation.
- C. Protect painted coatings from damage as a result of metal banding and rough handling. Use padded slings and straps.
- D. Store fabricated items in dry area, not in direct contact with ground.

### SWF BAF IMPROVEMENTS

# PART 2 PRODUCTS

### 2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Steel Pipe	A500, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade C
Aluminum:	
Aluminum Plates	B209, Alloy y6061-T6
Aluminum Structural Shapes	B308/B308M, Alloy 6061-T6
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844

Item	ASTM Reference
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

B. Bolts, Washers, and Nuts: Use stainless steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

# 2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

- A. Cast-In-Place Anchor Bolts:
  - 1. Headed type, unless otherwise shown on the Drawings.
  - 2. Material type and protective coating as shown in Fastener Schedule at end of this section.
- B. Anchor Bolt Sleeves:
  - 1. Plastic:
    - a. Single unit construction with corrugated sleeve.
    - b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
    - c. Material: High-density polyethylene.
  - 2. Fabricated Steel: ASTM A36/A36M.

# 2.03 POST-INSTALLED CONCRETE AND MASONRY ANCHORS

A. See Section 05 05 19, Post-Installed Anchors.

### 2.04 ACCESSORIES

- A. Antiseizing Lubricant for Stainless Steel Threaded Connections:
  - 1. Suitable for potable water supply.
  - 2. Resists washout.

- 3. Manufacturers and Products:
  - a. Bostik, Middleton, MA; Neverseez.
  - b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

### B. Neoprene Gasket:

- 1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on the Drawings.
- 2. Thickness: Minimum 1/4 inch.
- 3. Furnish without skin coat.
- 4. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK1111LD.

### 2.05 FABRICATION

- A. General:
  - 1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
  - 2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
  - 3. Conceal fastenings where practical; where exposed, flush countersink.
  - 4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
  - 5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
  - 6. Fit and assemble in largest practical sections for delivery to Site.
- B. Materials:
  - 1. Use steel shapes, unless otherwise noted.
  - 2. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.
- C. Welding:
  - 1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
  - 2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
  - 3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
  - 4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
  - 5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
  - 6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer's instructions.
  - 7. Complete welding before applying finish.

METAL FABRICATIONS 05 50 00 - 6

- D. Painting:
  - 1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
  - 2. Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
- E. Electrolytic Protection: Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
- F. Watertight Seal: Where required or shown, furnish neoprene gasket. Cover full bearing surfaces.
- G. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.
- H. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

# 2.06 SOURCE QUALITY CONTROL

- A. Visually inspect all fabrication welds and correct deficiencies.
  - 1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
  - 2. Aluminum: AWS D1.2/D1.2M.
  - 3. Stainless Steel: AWS D1.6/D1.6M.

# PART 3 EXECUTION

# 3.01 INSTALLATION OF METAL FABRICATIONS

- A. General:
  - 1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
  - 2. Install rigid, substantial, and neat in appearance.
  - 3. Install manufactured products in accordance with manufacturer's recommendations.
  - 4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.

- B. Aluminum:
  - 1. Do not remove mill markings from concealed surfaces.
  - 2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
  - 3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.
- C. Pipe Sleeves:
  - 1. Provide where pipes pass through concrete or masonry.
  - 2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
  - 3. Provide center flange for water stoppage on sleeves in exterior or waterbearing walls.
  - 4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

# 3.02 CAST-IN-PLACE ANCHOR BOLTS

- A. Locate and hold anchor bolts in place with templates at time concrete is placed.
- B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.
- C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

# 3.03 ELECTROLYTIC PROTECTION

- A. Aluminum:
  - 1. Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
  - 2. Allow coating to dry before installation of the material.
  - 3. Protect coated surfaces during installation.
  - 4. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.
- B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

# C. Stainless Steel:

- 1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
- 2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
- 3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
- 4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
- 5. After treatment, visually inspect surfaces for compliance.

### 3.04 PAINTING

A. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

# 3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Control:
  - 1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control.
  - Manufacturer's Certificate of Compliance per Section 01 61 00, Common Product Requirements, for test results, or calculations, or Drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements and Section 01 88 15, Anchorage and Bracing.

### 3.06 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Stainless steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09 90 00, Painting and Coating

### SWF BAF IMPROVEMENTS

Service Use and Location	Product	Remarks	
2. Anchor Bolts Cast Into	2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment		
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating	
3. Post-Installed Anchors:	See Section 05 05 19, Post-	Installed Anchors	
4. Anchors Cast in Grout-	Filled Concrete Masonry Un	its	
Dry Areas	Stainless steel headed anchor bolts or stainless steel sleeve anchors		
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts, stainless steel sleeve anchors		
5. Connections for Structu	5. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength stainless steel bolted connections		
6. Connections for Steel Fabrications and Wood Components			
Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections		
7. Connections of Aluminum Components			
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment		
8. All Others			
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners		

B. Antiseizing Lubricant: Use on stainless steel threads.

# **END OF SECTION**

# SECTION 09 90 00 PAINTING AND COATING

# PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Water Works Association (AWWA):
    - a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
    - b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
    - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
    - d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
  - 2. Environmental Protection Agency (EPA).
  - 3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
  - 4. NSF International (NSF): 61, Drinking Water System Components Health Effects.
  - 5. Occupational Safety and Health Act (OSHA).
  - 6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
  - 7. The Society for Protective Coatings (SSPC):
    - a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
    - b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
    - c. SP 1, Solvent Cleaning.
    - d. SP 2, Hand Tool Cleaning.
    - e. SP 3, Power Tool Cleaning.
    - f. SP 5, White Metal Blast Cleaning.
    - g. SP 6, Commercial Blast Cleaning.
    - h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
    - i. SP 10, Near-White Blast Cleaning.
    - j. SP 11, Power Tool Cleaning to Bare Metal.
    - k. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
    - 1. SP 13, Surface Preparation of Concrete.
    - m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

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### SWF BAF IMPROVEMENTS

### 1.02 DEFINITIONS

- A. Terms used in this section:
  - 1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
  - 2. FRP: Fiberglass Reinforced Plastic.
  - 3. HCl: Hydrochloric Acid.
  - 4. MDFT: Minimum Dry Film Thickness, mils.
  - 5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
  - 6. Mil: Thousandth of an inch.
  - 7. PDS: Product Data Sheet.
  - 8. PSDS: Paint System Data Sheet.
  - 9. PVC: Polyvinyl Chloride.
  - 10. SFPG: Square Feet per Gallon.
  - 11. SFPGPC: Square Feet per Gallon per Coat.
  - 12. SP: Surface Preparation.

### 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Data Sheets:
      - 1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
      - 2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
      - 3) Technical and performance information that demonstrates compliance with specification.
      - 4) Furnish copies of paint system submittals to the coating applicator.
      - 5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
    - b. Detailed chemical and gradation analysis for each proposed abrasive material.
  - 2. Samples:
    - a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.
    - b. Reference Panel:
      - 1) Surface Preparation:
        - a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.

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- b) Provide panel representative of the steel used; prevent deterioration of surface quality.
- c) Panel to be reference source for inspection upon approval by Engineer.
- 2) Paint:
  - a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
  - b) Furnish additional samples as required until colors, finishes, and textures are approved.
  - c) Approved samples to be the quality standard for final finishes.
- B. Informational Submittals:
  - 1. Applicator's Qualification: List of references substantiating experience.
  - 2. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
  - 3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
  - 4. Manufacturer's written verification that submitted material is suitable for the intended use.
  - 5. Coating for Faying Surfaces: Manufacturer's test results that show the proposed coating meets the slip resistance requirements of the AISC Specification for Structural Joints using ASTM A325 or ASTM A490 bolts.
  - 6. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
  - 7. Manufacturer's written instructions and special details for applying each type of paint.

# 1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.
- B. Regulatory Requirements:
  - 1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
  - 2. Perform surface preparation and painting in accordance with recommendations of the following:
    - a. Paint manufacturer's instructions.
    - b. SSPC PA 10.
    - c. Federal, state, and local agencies having jurisdiction.

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- C. Mockup:
  - 1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
  - 2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Shipping:
  - 1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
  - 2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.
- B. Storage:
  - 1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
  - 2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

### 1.06 PROJECT CONDITIONS

- A. Environmental Requirements:
  - 1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
  - 2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

# PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.
- B. Minimum of 5 years' verifiable experience in manufacture of specified product.

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- C. Each of the following manufacturers is capable of supplying most of the products specified herein:
  - 1. Tnemec Coatings, Kansas City, MO.
  - 2. ICI Devoe Coatings, Louisville, KY.
  - 3. Sherwin Williams, Cleveland, OH.
  - 4. Benjamin Moore Paints, New York, NY.

# 2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

# 2.03 PAINT MATERIALS

- A. General:
  - 1. Manufacturer's highest quality products suitable for intended service.
  - 2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
  - 3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.
- B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single-component, coal-tar pitch based
Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service

Product	Definition
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer— Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy Primer— Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61

Product	Definition
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Organic Zinc Rich Primer	Epoxy or moisture cured urethane with 85-percent zinc content in the dry film, meeting the requirements of RCSC Specification for Structural Joints using High Strength Bolts, Class A or Class B, as required.
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

### 2.04 MIXING

- A. Multiple-Component Coatings:
  - 1. Prepare using each component as packaged by paint manufacturer.
  - 2. No partial batches will be permitted.
  - 3. Do not use multiple-component coatings that have been mixed beyond their pot life.
  - 4. Furnish small quantity kits for touchup painting and for painting other small areas.
  - 5. Mix only components specified and furnished by paint manufacturer.
  - 6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
- B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

### 2.05 SHOP FINISHES

- A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.
- B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

- C. Shop Coating Requirements:
  - 1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
  - 2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.
- D. Pipe:
  - 1. Ductile Iron Pipe:
    - a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
    - b. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.
    - c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
    - d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
  - 2. Steel Pipe:
    - a. Surface preparation and application of primer and finish coats shall be performed by pipe manufacturer.
    - b. For pipe with epoxy lining, do not place end cap seals until pipe lining material has sufficiently dried.

# PART 3 EXECUTION

- 3.01 GENERAL
  - A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
  - B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.
  - C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.
# 3.02 EXAMINATION

- A. Factory Finished Items:
  - 1. Schedule inspection with Engineer before repairing damaged factoryfinished items delivered to Site.
  - 2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.
- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

## 3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.

## 3.04 SURFACE PREPARATION

- A. Field Abrasive Blasting:
  - 1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
  - 2. Refer to coating systems for degree of abrasive blasting required.
  - 3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.

- B. Surface Contamination Testing:
  - 1. A surface contamination analysis test shall be performed every 500 square feet by means of a Chlor Test CSN Salts.
  - 2. Surface with chloride levels exceeding  $3 \mu g$ /square centimeter for submerged surfaces and  $5 \mu g$ /square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR\*RID (CHLOR\*RID International, Chandler, AZ).
  - 3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.
- C. Metal Surface Preparation:
  - 1. Where indicated, meet requirements of SSPC Specifications summarized below:
    - a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
    - b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
    - c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
    - d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
    - e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
    - f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
    - g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

- h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
- i. SP-16, Brush Blasting of Non-Ferrous Metals: A brush-off blast cleaned non-ferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil).
- 2. The words "solvent cleaning", "hand tool cleaning", "wire brushing", and "blast cleaning", or similar words of equal intent in these Specifications or in paint manufacturer's specification refer to the applicable SSPC Specification.
- 3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
- 4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
- 5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
- 6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
- 7. Welds and Adjacent Areas:
  - a. Prepare such that there is:
    - 1) No undercutting or reverse ridges on weld bead.
    - 2) No weld spatter on or adjacent to weld or any area to be painted.
    - 3) No sharp peaks or ridges along weld bead.
  - b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
- 8. Preblast Cleaning Requirements:
  - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
  - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
  - c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.

- 9. Blast Cleaning Requirements:
  - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
  - b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
  - c. Use only dry blast cleaning methods.
  - d. Do not reuse abrasive, except for designed recyclable systems.
  - e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
- 10. Post-Blast Cleaning and Other Cleaning Requirements:
  - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
  - b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.
- D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:
  - 1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
  - 2. Brush blast in accordance with SSPC SP 16.
  - 3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.
- E. Concrete Surface Preparation:
  - 1. Do not begin until 30 days after concrete has been placed.
  - 2. Meet requirements of SSPC SP 13.
  - 3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
  - 4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.

- 5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
- 6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.
- F. Plastic and FRP Surface Preparation:
  - 1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
  - 2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.
- G. Masonry Surface Preparation:
  - 1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
  - 2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
  - 3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
    - a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
    - b. Brush-off blasting.
    - c. Water blasting.
  - 4. Do not damage masonry mortar joints or adjacent surfaces.
  - 5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
  - 6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
  - 7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.
- H. Existing Painted Surfaces to be Repainted Surface Preparation:
  - 1. Detergent wash and freshwater rinse.
  - 2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
  - 3. Feather surrounding intact coating.
  - 4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
  - 5. Apply one full finish coat of specified primer to entire surface.
  - 6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.

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- 7. Application of Cosmetic Coat:
  - a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
  - b. Check compatibility by application to a small area prior to starting painting.
  - c. If lifting or other problems occur, request disposition from Engineer.
- 8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

## 3.05 SURFACE CLEANING

- A. Brush-off Blast Cleaning:
  - 1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
  - 2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
  - 3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
  - 4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
  - 5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
  - 6. Repair or replace surface damaged by blast cleaning.
- B. Acid Etching:
  - 1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
  - 2. Application:
    - a. Rate: Approximately 2 gallons per 100 square feet.
    - b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
    - c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
    - d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
    - e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
    - f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
  - 3. Ensure surface is completely dry before application of coating.
  - 4. Apply acid etching to obtain a "grit sandpaper" surface profile. If not, repeat treatment.

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- C. Solvent Cleaning:
  - 1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
  - 2. Meet requirements of SSPC SP 1.

## 3.06 APPLICATION

- A. General:
  - 1. The intention of these Specifications is for existing and new, interior and exterior masonry, concrete, and metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
  - 2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
  - 3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
  - 4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
  - 5. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
  - 6. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
  - 7. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
  - 8. Keep paint materials sealed when not in use.
  - 9. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.
- B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:
  - 1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
  - 2. Prepare surface and apply primer in accordance with System No. 10 specification.

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- 3. Apply intermediate and finish coats of the coating system appropriate for the exposure.
- C. Porous Surfaces, Such As Concrete and Masonry:
  - 1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
  - 2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
    - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
  - 3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.
- D. Film Thickness and Coverage:
  - 1. Number of Coats:
    - a. Minimum required without regard to coating thickness.
    - b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
  - 2. Application Thickness:
    - a. Do not exceed coating manufacturer's recommendations.
    - b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
  - 3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
    - a. Perform with properly calibrated instruments.
    - b. Recoat and repair as necessary for compliance with specification.
    - c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
  - 4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
  - 5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
  - 6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

## 3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

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B. System No. 1 Submerged Metal—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	NSF Epoxy	3 coats, 3 MDFTPC

- 1. Use on the following items or areas:
  - a. Metal surfaces new and existing below a plane 1 foot above the maximum liquid surface; metal surfaces above the maximum liquid surface that are a part of the immersed equipment; surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel that are embedded in concrete; and the following specific surfaces:
    - 1) Interior surfaces of steel piping noted in the Piping Schedule.
- C. System No. 4 Exposed Metal—Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer— Ferrous Metal	1 coat, 2.5 MDFT
	High Build Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

- 1. Use on the following items or areas:
  - a. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather, and the following specific surfaces:
    - 1) Exterior surfaces of steel piping noted in the Piping Schedule.
    - 2) Pumps and miscellaneous equipment items identified in the Specifications to be coated with this system.
    - 3) All exposed to view ductile iron and carbon steel pipes, valves, and appurtenance surfaces, and exterior surface of welded steel tanks.
    - 4) Exposed metal surfaces, located inside or outside of structures and exposed to weather or in a highly huic atmosphere, such as pipe galleries and similar areas.

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Standard Hot Coal-Tar Enamel -OR-	AWWA C203
	Coal-Tar Epoxy	2 coats, 16 MDFT
	For Highly Abrasive Soil, Brackish Water: Tape Coat System	AWWA C214 with Double Outer Wrap

D. System No. 8 Buried Metal—General:

- 1. For steel pipe and fittings, follow AWWA C209 and AWWA C214.
- 2. Use on the following items or areas:
  - a. Buried ductile iron pipe.
- E. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

- 1. Use on the following items or areas:
  - a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

### 3.08 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 106 Galvanized Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Manufacturer's Recommended Primer	1 coat, as recommended by manufacturer
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

- 1. Use on the following items or areas:
  - a. As shown in finish schedule on the Drawings.

## 3.09 COLORS

- A. Provide as selected by Owner or Engineer.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.
- C. Equipment Colors:
  - 1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
  - 2. Paint equipment and piping one color as selected.
  - 3. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
    - a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
    - b. Fire Protection Equipment and Apparatus: OSHA Red.
    - c. Radiation Hazards: OSHA Purple.
    - d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.
- D. Pipe Identification Painting:
  - 1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
  - 2. Pipe Color Coding: To match existing piping.

- 3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
- 4. Pipe Supports: Painted light gray, as approved by Owner.
- 5. Fiberglass reinforced plastic (FRP) pipe, polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC) pipe located inside of buildings and enclosed structures will not require painting, except as noted or scheduled.

## 3.10 FIELD QUALITY CONTROL

- A. Testing Equipment:
  - 1. Provide calibrated electronic type dry film thickness gauge to test coating thickness specified in mils.
  - 2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
  - 3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.
- B. Testing:
  - 1. Thickness and Continuity Testing:
    - a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
    - b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
    - c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
    - d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.
- C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

- D. Unsatisfactory Application:
  - 1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
  - 2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
  - 3. Repair defects in accordance with written recommendations of coating manufacturer.
- E. Damaged Coatings, Pinholes, and Holidays:
  - 1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
  - 2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
  - 3. Feather edges and repair in accordance with recommendations of paint manufacturer.
  - 4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

### 3.11 MANUFACTURER'S SERVICES

- A. In accordance with Section 01 43 33, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:
  - 1. On first day of application of any coating system.
  - 2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
  - 3. As required to resolve field problems attributable to or associated with manufacturer's product.
  - 4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

### 3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

## 3.13 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification:
  - 1. Paint System Data Sheet (PSDS).
  - 2. Paint Product Data Sheet (PPDS).

## **END OF SECTION**

# PAINT SYSTEM DATA SHEET

Complete this PSDS for <u>each</u> coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from S	Spec.):				
Paint System Title (from Spec	c.):				
Coating Supplier:					
Representative:					
Surface Preparation:					
Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats, Coverage			

# PAINT PRODUCT DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PPDS for <u>each</u> product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio:		
Maximum Permissible Thinning:	-	
Ambient Temperature Limitations:	min.:	max.:
Surface Temperature Limitations:	min.:	max.:
Surface Profile Requirements:	min.:	max.:

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

## SECTION 09 97 13 STEEL TANK COATINGS

## PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. NACE International: SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
  - 2. NSF International (NSF): 61, Drinking Water System Components Health Effects.
  - 3. Society for Protective Coatings (SSPC):
    - a. Surface Preparation Standards:
      - 1) SP 1, Solvent Cleaning.
      - 2) SP 2, Hand Tool Cleaning.
      - 3) SP 3, Power Tool Cleaning.
      - 4) SP 5, White Metal Blast Cleaning.
      - 5) SP 7, Brush-Off Blast Cleaning.
      - 6) SP 10, Near White Blast Cleaning.
      - 7) SP 11, Power Tool Cleaning to Bare Metal.
      - 8) SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
    - b. Paint Application Guides:
      - 1) PA 1, Shop, Field, and Maintenance Painting of Steel.
      - 2) PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
      - 3) PA Guide 10, Guide to Safety and Health Requirements for Industrial Painting Projects.

### 1.02 DEFINITIONS

- A. Terms used in this section:
  - 1. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
  - 2. MDFT: Minimum Dry Film Thickness, mils.
  - 3. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
  - 4. Mil: Thousandth of an inch.
  - 5. PPDS: Paint Product Data Sheet.
  - 6. PSDS: Paint System Data Sheet.
  - 7. SP: Surface preparation.
  - 8. VOC: Volatile Organic Compounds.

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## 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Data Sheets:
    - a. For each paint system used, furnish a Paint System Data Sheet (PSDS), Paint Product Data Sheet (PPDS), and paint colors available (where applicable) for each product used in paint system. The PSDS and PPDS forms are appended to the end of this section.
    - b. Submit required information on a system-by-system basis.
    - c. Provide copies of paint system submittals to coating applicator.
    - d. Also provide copies of paint system submittals to the coating applicator.
    - e. Indiscriminate submittal of manufacturer's literature only is not acceptable.
  - 2. Detailed chemical and gradation analysis for each proposed abrasive material.
  - 3. Samples:
    - a. For each paint system used, furnish colors available (where applicable) for each product used in paint system.
- B. Informational Submittals:
  - 1. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
  - 2. Current NSF certification for potable water contact, where applicable.
  - 3. Anticipated tank coating sequence.
  - 4. Dehumidification plan, including equipment and air change rates. Submit plan based on type of equipment used, length of time required to hold blast, tank volume, and time of year that coating work is undertaken.
  - 5. Applicator's Qualification: List of references substantiating experience.
  - 6. Independent structural Engineer review of proposed tank containment system.
  - 7. Shop and field applicator's quality control program, including, but not limited to:
    - a. Environmental test methods and frequency.
    - b. Steel surface temperature and profile measurement procedure and frequency.
    - c. Record keeping form.
    - d. Submit Quality Control Plan in accordance with Section 01 45 16.13, Contractor Quality Control.
      - Section 01 45 16.13, Contractor Quality Control.
  - 8. Manufacturer's written instructions for applying each type of coating.

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- 9. When self-contained blast cleaning equipment using recycled abrasives is proposed. Submit the following:
  - a. List of at least three successful projects within past 3 years where equipment and procedures have been used on steel tank of similar size and dimensions.
  - b. Provide tank owner's name and telephone numbers.
  - c. Description of proposed equipment, procedures, and abrasive blast mix to be used.
- 10. Field Testing: Inspection and test reports.
- 11. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

## 1.04 QUALITY ASSURANCE

- A. Applicator Qualifications:
  - 1. Minimum 5 years' experience in application of specified products.
  - 2. Certified by coating manufacturer for application of 100 percent solids epoxy.
- B. Regulatory Requirements:
  - 1. Meet federal, state, and local agencies having jurisdiction for Site and types of work activities included in Project, including, but not limited to:
    - a. Limitations on emission of volatile organic compounds, dust, and other contaminants.
    - b. Requirements for disturbance, handling, and disposal of paint waste and associated debris, including lead, coal tar, abrasive, and other regulated substances.
- C. Industry Best Practices:
  - 1. Perform surface preparation and painting in accordance with recommendations of the following:
    - a. Paint manufacturer's instructions.
    - b. SSPC–PA Guide 10.
  - 2. Do not apply paint in temperatures outside of manufacturer's recommended maximum or minimum allowable, in dust, in smoke-laden atmosphere, in damp or humid weather.
  - 3. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent or whenever surface temperature is less than 5 degrees F above dewpoint of ambient air.

- D. Mockup:
  - 1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
  - 2. After approval, sample spaces or items shall serve as a standard for similar work throughout the Project.
- E. Preinstallation Meeting:
  - 1. Prior to beginning painting Work, schedule a meeting and be prepared to discuss the following subjects, as a minimum:
    - a. Required schedule.
    - b. Sequence of critical path work items.
    - c. Use of Site, access, office and storage areas, security, and temporary facilities.
    - d. Major product delivery and priorities.
    - e. Safety plan.
  - 2. Attendees shall include:
    - a. Owner's representatives.
    - b. Contractor's office representative.
    - c. Contractor's resident superintendent.
    - d. Contractor's quality control representative.
    - e. Subcontractors' representatives whom Contractor may desire or
    - Engineer may request to attend.
    - f. Engineer's representative.
    - g. Paint manufacturer's technical representative.
    - h. Others as appropriate.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Shipping:
  - 1. Protect precoated items from damage. Batten coated items to prevent abrasion.
  - 2. Use nonmetallic or padded slings and straps in handling.
- B. Deliver materials to Site in unopened containers labeled with designated name, date of manufacture, color, and manufacturer.
- C. Store paints in a protected area that is heated or cooled as required to maintain temperatures within range recommended by paint manufacturer.

## 1.06 SPECIAL GUARANTEE

- A. Furnish extended guarantee or warranty. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of Work specified in this specification section found defective during a period of 2 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.
  - 1. 24-Month Warranty Period Inspection: Owner will conduct inspection of interior and exterior coated surfaces prior to the end of warranty period. Owner will notify Contractor in advance of inspection and Contractor may attend at its option. Owner will prepare list of coating defects and failures identified during inspection and transmit to Contractor. List shall serve as notice of repairs required under warranty.
  - 2. Repairs:
    - a. If repairs are required, requirements of Contract shall apply including, but not limited to, requirements to remove standing water in tanks, perform repair work, and tank cleaning prior to disinfection.
    - b. Repair defective coatings using coating materials, equipment, and methods similar to those used in original work. Materials shall be of fresh manufacture and within manufacturer's stated shelf life at time of application.
    - c. Provide extended warranty of 1 year for repairs.
    - d. Complete repairs within 30 calendar days of Warranty Period Inspection.

# PART 2 PRODUCTS

- 2.01 GENERAL
  - A. Components and Materials in Contact with Water for Human Consumption:
    - 1. Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
    - 2. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
    - 3. Use or reuse of components and materials without a traceable certification is prohibited.

#### 2.02 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of: Tnemec Coatings, Kansas City, MO.

### 2.03 MATERIALS

- A. Quality: Manufacturer's highest quality products and suitable for intended use.
- B. Materials Including Primer and Finish Coats: Produced by same paint manufacturer.
- C. Thinners, Cleaners, Driers, and Other Additives: As recommended by paint manufacturer of the particular coating.
- D. NSF Epoxy, 100 Percent Solids: Two-component, 100 percent solids epoxy for water tank lining, approved for potable water contact conforming to NSF 61 (including recent update with NSF 61/600).
- E. Epoxy Primer: Two-component, polyamidoamine, phenalkamine, or polyamide cured epoxy, compatible with specified finish. Primer that may contact potable water shall conform to NSF/ANSI 61. Primer for exterior exposed surfaces may contain anticorrosive pigments.
- F. Polyurethane Enamel: Two-component, aliphatic or acrylic based polyurethane; semi-gloss finish.
- G. Caulking: Two-component polyurethane caulk, suitable for potable water contact conforming to NSF 61 and compatible with the NSF Epoxy.

#### 2.04 COLORS

- A. Formulate with colorants free of lead and lead compounds.
- B. Furnish as selected by the City.
- C. Proprietary identification of colors is for identification only. Selected manufacturer will supply matches.

### 2.05 MIXING

- A. Multiple-Component Coatings:
  - 1. Prepare using contents of container for each component as packaged by paint manufacturer.
  - 2. No partial batches will be permitted.

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- 3. Do not use multiple-component coatings that have been mixed beyond their pot life.
- 4. Furnish small quantity kits for touchup painting and for painting other small areas.
- 5. Mix only components specified and furnished by paint manufacturer.
- 6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
- B. Keep paint material containers sealed when not in use.

### 2.06 ABRASIVES

- A. Select abrasive type and size to produce a surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.
- B. Select abrasives that conform to federal and state regulations for metals and toxicity.

### 2.07 SOURCE QUALITY CONTROL

- A. Prime coat structural steel surfaces.
- B. Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints. Work shall be subject to Engineer's approval before shipment to Site.

### PART 3 EXECUTION

- 3.01 GENERAL
  - A. Surface Preparation and Coating Application: Meet or exceed requirements of these Specifications and SSPC–PA 1, whichever is more stringent.
  - B. Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied.
  - C. Paint new interior and exterior exposed metal surfaces whether specifically mentioned or not, except as modified herein.
  - D. Provide Engineer a minimum of 7 days' advanced notice prior to start of surface preparation work or coating application work. Perform such work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

- E. Schedule inspection with Engineer in advance for cleaned surfaces and coats prior to succeeding coat.
- F. Do not apply paint in temperatures outside of manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.
- G. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dewpoint of ambient air.
- H. Ventilation for Coating Cure: Provide fans to continuously ventilate tank interior, as required, to assist with coating cure.

### 3.02 PREPARATION

- A. Items such as structural steel, metal floor doors, manways, and frames, metal louvers, and similar fabricated items may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternative to shop blast cleaning.
- B. Remove, mask, or otherwise protect hardware, machined surfaces, nameplates, and other surfaces not intended to be painted.
- C. Protect surfaces adjacent to or downwind of Work area from overspray.

## 3.03 ENVIRONMENTAL CONTROLS

- A. Containment System:
  - 1. Provide full containment of blast emissions during entire blast operation for tank exterior. Meet requirements of SSPC–Guide 6 as modified below.
    - a. Design: Reviewed by structural engineer, licensed in the State of Florida. Consider load bearing capacity of roof for supporting containment system.
    - b. Provide Class 1 containment structure. Completely shroud tank with opaque fabric that prevents spread of blast media, spent chips, corrosion byproducts, and dust.
    - c. Exhaust air shall be filtered by appropriately sized dust collectors.
    - d. Verify effectiveness using Method A, General Surveillance, Level 2, as described in SSPC–Guide 6.

- B. Dehumidification Equipment:
  - 1. Provide full-time dehumidification for field painting interior of tank. Dehumidification and heating equipment shall be provided by a supplier with at least 3 years' experience with necessary equipment.
  - 2. Use dehumidification and heating equipment to control environment 24 hours a day during blast cleaning and coating application. At Contractor's option, dehumidification equipment may also be used during curing process.
  - 3. Provide desiccant dehumidifiers with a single rotary desiccant wheel capable of fully continuous operation. No liquid, granular, or loose lithium chloride drying systems will be allowed.
  - 4. Seal interior space of tank and maintain a slight positive pressure as recommended by supplier of dehumidification equipment.
  - 5. During blasting operation, dehumidification equipment shall continuously maintain a dewpoint of air inside tank at least 5 degrees F less than temperature of coldest part of tank where the Work is underway. Inside relative humidity shall not exceed 45 percent, unless specifically required by paint manufacturer for coating application and cure.
  - 6. Provide auxiliary heat as necessary to maintain surface temperature in the range specified by the coating manufacturer. Auxiliary heating equipment shall be approved for use by dehumidification equipment supplier and shall meet the following requirements:
    - a. Install heaters in process air supply duct between, and blended with, dehumidifier as close to space as possible.
    - b. Use electric, indirect fired combustion, or steam coil auxiliary heaters. Direct fired space heaters will not be allowed during blasting, coating, or curing cycles.
    - c. Equip heaters with controls that automatically turn heater off if airflow is interrupted or internal temperature of heater exceeds its design temperature or design temperature of supply duct.
  - 7. Measure and record ambient temperature, relative humidity, dewpoint and tank wall temperature a minimum of twice daily (beginning and end of work shifts) to verify proper environmental levels are achieved inside tank. Field-measured test results shall be made available to Engineer upon request.
- C. Filtration System:
  - 1. Designed to remove dust from air so that it does not interfere with dehumidification equipment's ability to control dewpoint and relative humidity inside tank.
  - 2. Air from tank or dust filtration equipment shall not be recirculated through dehumidifier during coating application or when solvent vapors are present.

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### 3.04 PREPARATION OF SURFACES

- A. Metal Surfaces:
  - 1. Meet requirements of the following SSPC Specifications:
    - a. Solvent Cleaning: SP 1.
    - b. Hand Tool Cleaning: SP 2.
    - c. Power Tool Cleaning: SP 3.
    - d. White Metal Blast Cleaning: SP 5.
    - e. Brush-Off Blast Cleaning: SP 7.
    - f. Near-White Blast Cleaning: SP 10.
    - g. Power Tool Cleaning to Bare Metal: SP 11.
    - h. Brush Blasting of Non-Ferrous Metals: SP 16.
  - 2. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.
  - 3. Where air quality regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
  - 4. Preblast Cleaning Requirements:
    - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
    - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
    - c. Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.
    - d. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
    - e. Prepare welds and adjacent areas to eliminate undercutting or reverse ridges on weld bead, weld spatter on or adjacent to weld or other area to be painted, and sharp peaks or ridges along weld bead.
    - f. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
  - 5. Blast Cleaning Requirements:
    - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.

- b. Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.
- c. Use only dry blast cleaning methods.
- d. Do not reuse abrasive, except for designed recyclable systems.
- e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning and disposition of spent aggregate and debris.
- 6. Post-blast Cleaning and Other Cleaning Requirements:
  - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
  - b. Paint surfaces the same day they are blast cleaned. Reblast surfaces that have started to rust before they are coated.

## 3.05 APPLICATION

- A. General:
  - 1. The intention of these Specifications is for new, interior metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as modified herein.
  - 2. Coatings Subject to Immersion:
    - a. Apply coatings to internal vessel, pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals unless otherwise specified.
    - b. Curing:
      - 1) Obtain full cure for completed system.
      - 2) Consult coatings manufacturer's written instructions.
      - 3) Do not immerse coating until completion of curing cycle.
  - 3. Apply coatings in accordance with paint manufacturer's recommendations. Allow sufficient time between coats to ensure thorough drying of previously applied coat.
  - 4. Prior to assembly or installation, paint units to be bolted together and to structures.
  - 5. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that required number of coats have been applied.
  - 6. With brush, work coating into and behind anchor bolts, anchor chairs, and other areas that are difficult to paint by spray.

- B. Shop Primed Surfaces:
  - 1. As specified in Article Protective Coatings Systems and Application Schedule.
  - 2. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
  - 3. For two-package or converted coatings, consult coatings manufacturer for specific procedures as relates to manufacturer's products.
  - 4. Prior to application of finish coats, clean shop primed surfaces free of dirt, oil, and grease and apply one coat of specified primer.
  - 5. After welding, prepare and prime holdback areas as required for specified paint system. Apply primer in accordance with manufacturer's instructions.
- C. Stripe Coating:
  - 1. Consists of one coat, brush applied, to coating thickness specified.
  - 2. Apply between primer and intermediate coats.
  - 3. Color shall contrast intermediate coat to allow visual verification of application.
  - 4. Apply to field welds, edges, angles, fasteners, and other irregular surfaces located inside tanks.
- D. Film Thickness and Coverage:
  - 1. Number of Coats:
    - a. Minimum required without regard to coating thickness.
    - b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
  - 2. Maximum film build per coat shall not exceed coating manufacturer's recommendations.

## 3.06 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. System No. 1A Submerged Metal—Potable Water (NSF Epoxy):

Surface Prep.	Paint Material	Min. Coats, Cover
Shop: Solvent clean and abrasive blast or	NSF Epoxy (Shop Applied, White)	1 coat, 4 MDFT
centrifugal wheel blast (SP 5)	NSF Epoxy (white), Spot Repairs and Welds	1 coat, 4 MDFT

Surface Prep.	Paint Material	Min. Coats, Cover
Field: Brush-off blast shop primer, abrasive	Stripe Coat with NSF Epoxy (grey or beige)	1 coat, 3 MDFT
blast areas of damaged primer, and field weld holdback areas to white	NSF Epoxy Intermediate Coat (grey or beige)	1 coat, 4 MDFT
metal (SP 5)	NSF Epoxy Finish Coat (white)	1 coat, 4 MDFT

1. Minimum Dry Film Thickness, Total System:

a. Nonstripe Coated Areas: 12 MDFT.

- b. Stripe Coated Areas: 15 MDFT.
- 2. Application Schedule:
  - a. Coat all metal surfaces inside tank, including, but not limited to, steel plates, structural steel, exposed surfaces of inlet, outlet, and overflow piping, hatches, covers, ladders, landings, and couplings.
  - b. Coat all stainless steel surfaces inside tank. Coat interior surfaces of stainless steel pipe for a distance of 24 inches where stainless steel pipe is connected to coated carbon steel pipe.
  - c. Coat exterior surfaces of buried or concrete encased steel pipe.
  - d. Coating is not required for bottom side of floor plates.
  - e. Provide full coating thickness to structural steel surfaces that will be covered by roof plates or otherwise shielded from full coating thickness, before structural members are installed. Not required for surfaces located behind members that are fully seal welded.
  - f. Provide full coating thickness on bottom of column baseplates and top of steel floor surface under baseplates. Prepare surfaces, apply coating, and allow it to cure prior to installation of the columns. Not required for surfaces located behind members that are fully seal welded.

# 3.07 FIELD QUALITY CONTROL

- A. Test Equipment:
  - 1. Provide a dry film thickness gauge to test coating thickness as specified in mils. Use magnetic or electronic type as manufactured by Elcometer, DeFelsko, or equal.
  - 2. Provide electrical holiday detector, low voltage, wet sponge type to test finish coat less than 20 mils dry film thickness, as manufactured by Elcometer, Tinker, and Rasor, or equal.
  - 3. Provide high-voltage holiday detector to test finish coats 20 mils dry film thickness or greater. Provide equipment approved by the coating manufacturer.

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- B. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
  - 1. Perform with properly calibrated instruments.
  - 2. Repair or recoat defective areas as necessary for compliance with Specifications.
  - 3. All coats are subject to inspection by Engineer and coating manufacturer's representative.
  - 4. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
- C. Thickness Testing:
  - 1. Measure coating thickness specified in mils with magnetic or electronic type dry film thickness gauge in accordance with SSPC–PA 2.
  - 2. Check each coat for correct thickness. Do not make measurement before a minimum of 8 hours after application of coating.
  - 3. After repaired and recoated areas have dried sufficiently, repeat tests to demonstrate specified dry film thickness has been achieved.
- D. Holiday (Pinhole) Testing: Test finish coat on 100 percent of tank interior and all other submerged surfaces for holidays and discontinuities with low-voltage or high-voltage electrical holiday detector, depending on final dry film thickness. Conduct test in accordance with NACE SP0188.
- E. Unsatisfactory Application:
  - 1. If improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
  - 2. Evidence of runs, bridges, shiners, laps, or other imperfections are causes for rejection.
  - 3. Repair defects in coating systems in accordance with written recommendations of coating manufacturer.
  - 4. Leave staging up until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer.
- F. Damaged Coatings, Pinholes, and Holidays:
  - 1. Feather edges and repair in accordance with recommendations of paint manufacturer.
  - 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat in accordance with Specifications. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.

3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

# 3.08 MANUFACTURER'S SERVICES

- A. Coating manufacturer's technical representative shall be present at Site as follows:
  - 1. On the first day of application of coating.
  - 2. A minimum of three additional Site inspection visits, each for a minimum of 3 hours.
  - 3. As required for application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications.
  - 4. As necessary to resolve field problems attributable to or associated with manufacturer's products.
  - 5. To verify full cure of coating prior to placing coated surfaces into immersion service.

## 3.09 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.
- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave Site clean.

## 3.10 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification:
  - 1. Data Sheet: Example Paint System Data Sheet (PSDS).
  - 2. Data Sheet: Example Paint Product Data Sheet (PPDS).

# **END OF SECTION**

## PAINT SYSTEM DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PSDS for <u>each</u> coating system.

Paint System Number (from Spec.):					
Paint System Title (from Spec	c.):				
Coating Supplier:					
Representative:					
Surface Preparation:					
Paint Material (Generic) (Proprietary) Min. Coats, Coverage					

Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

 Ambient Temperature Limitations:
 min.:
 max.:

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Surface Temperature Limitations:	min.:	max.:
Surface Profile Requirements:	min.:	max.:

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.
# PAINT PRODUCT DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PDS for <u>each</u> product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio:					
Maximum Permissable Thinning:					
Ambient Temperature Limitations:	min.:	max.:			
Surface Temperature Limitations:	min.:	max.:			
Surface Profile Requirements:	min.:	max.:			

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

## SECTION 26 05 02 BASIC ELECTRICAL REQUIREMENTS

## PART 1 GENERAL

## 1.01 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

## 1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
  - 2. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - b. Z535.4, Product Safety Signs and Labels.
  - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 4. NFPA 79 Electrical Standard for Industrial Machinery.

## 1.03 SCOPE OF WORK

- A. Scope of Work includes, but is not limited to the following:
  - 1. The electrical site plan drawings present horizontal and vertical locations for new and existing buried utilities (piping, ductbanks and conduits). This information is provided only to indicate the intended relative location of new work relative to the existing buried utilities. The Contractor shall field verify horizontal and vertical locations for all buried utilities. The Contractor shall modify the horizontal and vertical locations for new piping, conduit and ductbank systems to maintain the relative spacing to the existing buried utilities.
  - 2. Prior to start of construction, the Electrical Contractor shall coordinate, trace, and verify all power and signals connection feeding ASR Well No. 1. All conduits to the ASR Well No. 1 equipment rack must be relocated as shown on Drawing 06-E-201.

- 3. Prior to the start of construction, the electrical contractor shall field coordinate the routing of all electrical conductors, conduit, and signal cables with the owner and General Contractor. Coordinate routing of runs for all outgoing power and control signals, and communication fiber, yard piping etc., from the High Service Pump Building to the Lake Transfer Pump Building, Biologically Activated Filter Pad, and ASR Well No. 1 with other trades.
- 4. An elevated pull box shall be installed east of the high service pump station building to route the new Variable Frequency Drive (VFD) cable to the new lake transfer pump. A custom bracket shall be design by the Contractor's engineer to support the pullbox.
- 5. Provide coordination study and arc-flash study as per Section 26 05 70, Electrical System Analysis.
- 6. Pulling calculation must be provided on variable frequency drive cables. Pulling compound must be used pulling variable frequency drive cable.
- 7. Field verify location of all conduit for power and signals connected to ASR Well No. 1. The conduits, power conductors and signal have to be relocated as shown on Drawing 06-E-201.
- 8. Remove and replaced 600A feeder breakers from existing switchboard and install one new 1200A LSI feeder breaker in existing switchboard. Follow sequence of construction as shown on Division 26, Electrical Specifications and Drawings.
- 9. Remove existing motor control centers (MCC-A, and MCC-B). Remove exiting MCC-A first.
- 10. Remove existing Lake Transfer Pump VFDs. Follow sequence of construction as shown on Division 26, Electrical Specifications and Drawings.
- 11. Furnish, install, and test new low-voltage 1200A distribution panelboard and interconnecting power and control cables as shown on the Drawings.
- 12. Furnish, install, and test new branch panelboards and dry type transformers. Interconnecting power and control cables as shown on the Drawings.
- 13. Coordinate installation of new variable frequency drives with pump manufacturer, and PICS contractor.
- 14. New variable frequency drive conductors will be routed, in conduit, inside high service pump building. Conduit fittings and with long bending radii, and large pull box will be required. Electrical contractor to verify best mounting location and route inside High Service Pump Building.
- 15. 12 pulse VFD transformers to be located outside as shown on the Drawings.
- 16. Furnish, install, and test a completely integrated grounding system for the new electrical equipment as shown on the Drawings.

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- 17. Furnish, install, terminate, and test all interconnecting power, control, and instrumentation wiring as shown on the Riser Diagrams and P&I Drawings.
- Contractor to design the supports for the elevated pullbox located on the east wall of the High Service Pump Building. Contractor shall submit calculation, and drawings in accordance with Section 01 88 15, Anchorage and Bracing.
- 19. Contractor to design the supports for the elevated transformers located on the west wall of the High Service Pump Building. Contractor shall submit calculation, and Drawings in accordance with Section 01 88 15, Anchorage and Bracing.
- 20. Furnish and install all conduit, wiring, and field connections for all motors, motor controllers, control devices, control panels, and electrical equipment furnished under other Division of these Specifications.
- 21. Furnish and install equipment ground conductor sized per Table 250-122 of the NEC in all new conduits and existing re-used conduits.
- 22. Conduct and participate in all electrical and contractor's testing. Specifically, all operational readiness tests and functional acceptance tests shall be jointly conducted by the Contractor and the electrical subcontractor.
- 23. Sequence work to meet the Contractor's overall schedule and construction sequence.
- 24. The Work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.
- 25. The Work shall include complete coordination with Contractor and other subcontractors. Coordinate with Contractor and all other subcontractor's equipment submittals and obtain all relevant submittals.
- 26. All power interruptions to electrical equipment shall be at the Owner's convenience with one week (minimum) notice. Each interruption shall have prior approval.
- 27. The Contractor's work shall not interfere with existing plant operation. Temporary power connections required to maintain plant operation shall be provided by the Contractor supplied portable trailer mounted generator at no additional expense to the Owner. All temporary wiring shall be in accordance with the NEC.
- 28. Field verify all existing underground electrical and mechanical piping.
- 29. Directional boring is prohibited. When excavation new ductbanks use mini excavator with no teeth. Nothing bigger is allowed.

- 30. The Contractor shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuit shall be used unless approved in writing by the Owner. Any temporary added shall be removed at job completion.
- 31. Provide modifications to existing control systems including installation of auxiliary motor starter contacts, relays, switches, etc., as required to provide the control functions or inputs as shown on the Drawings. Obtain the existing equipment Shop Drawings from the Owner before attempting to make any modifications to the existing equipment wiring. Verify all existing wiring and connections for correctness. If record drawings are not available, trace all circuits in the field and develop the wiring diagrams necessary for completion of the word. Document all changes made to the wiring diagrams and return a marked-up set of record drawings to the Owner after the Work is complete.
- 32. Coordinate the sequence of demolition with the sequence of construction to maintain plant operation at all times. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment.
- 33. Modifications to panelboards, and motor controllers, including installation of circuit breakers, etc., or disconnection of circuits as required, to provide the power supplies to new and existing equipment to maintain all facilities and buildings in operation.
- 34. Provide all electrical demolition work associated with the removal of equipment from the existing facilities, including disconnecting and removing all electrical wiring and conduit to equipment being removed under other sections. Survey the existing electrical systems with representatives from other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

## 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Provide manufacturers' data for the following:
    - a. Electrical service components.
    - b. Nameplates, signs, and labels.
  - 2. Anchorage and bracing drawings and catalog information, as required by Section 01 88 15, Anchorage and Bracing, for loads in Section 01 61 00, Common Product Requirements.
- B. Informational Submittals: Anchorage and bracing calculations, as required by Section 01 88 15, Anchorage and Bracing, for loads in Section 01 61 00, Common Product Requirements.

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- C. Quality Control Submittals:
  - 1. Voltage field test results.
  - 2. Voltage balance report.
  - 3. Equipment line current report.
  - 4. Factory test certification and reports for all major electrical equipment.
  - 5. Site test certification and reports as specified in other Division 26, Electrical sections.

## 1.05 QUALITY ASSURANCE

- A. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.
- B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

## 1.06 ENVIRONMENTAL CONDITIONS

- A. The following areas are classified nonhazardous and wet. Use materials and methods required for such areas.
  - 1. Outdoor abovegrade areas not covered above.
  - 2. High Service Pump Building.
  - 3. Lake Transfer Pump Building
  - 4. Belowgrade vaults.

## 1.07 DEMOLITION

- A. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.
- B. Remove unused exposed conduit and wiring back to point of concealment including abandoned conduit above accessible ceiling finishes. Remove unused wiring in concealed conduits back to source (or nearest point of usage).
- C. Disconnect electrical circuits in the way of demolition work and re-establish circuits to remaining outlets, fixtures, equipment, etc. Disconnect electrical systems in wall, floors and ceilings scheduled for removal.

- D. Repair adjacent construction and finishes damaged during demolition and extension work.
- E. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.
- F. Coordinate outages in systems with the Owner. Where duration on proposed outage cannot be allowed by the Owner, provide temporary connections as required to maintain service.
- G. Removal and relocation of existing conduit, wire and equipment have not been detailed on the Drawings. Survey the affected areas before submitting bid proposal.
- H. Trace out existing wiring that is to be relocated, or removed and perform the relocation or removal work as required for a complete operating and safe system.
- I. Remove exposed conduits, wireways, outlet boxes, pull boxes, and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide stainless steel blank covers for abandoned outlets which are removed.
- J. All existing electrical equipment to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.
- K. Conduit and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed, salvaged and stored. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduit shall be suitably plugged and the area repaired in a flush, smooth and approved manner. Exposed conduit and their supports shall be disassembles and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.
- L. Miscellaneous electrical equipment shall be removed and disposed of off the Site as required. Care shall be taken in removing all equipment so as to minimize damage to architectural and structural members. Any damage incurred shall be repaired.

## 1.08 DISPOSITION OF REMOVED MATERIALS AND EQUIPMENT

A. In general, it is intended that material and equipment indicated to be removed and disposed of by the Contractor shall, upon removal, become the contractor's property and shall be disposed of off the site by the Contractor, unless otherwise directed by the Owner. Any fees or charges incurred for disposal of such equipment or material shall be paid by the Contractor. A receipt showing acceptable disposal of any legally regulated materials or equipment shall be given to the Owner.

## PART 2 PRODUCTS

#### 2.01 GENERAL

- A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.
- C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range stated in Section 01 61 00, Common Product Requirements.

#### 2.02 EQUIPMENT FINISH

A. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance.

#### 2.03 NAMEPLATES

- A. Material: Laminated plastic attached to panel with stainless steel screws.
- B. Attachment Screws: Adhesive: Single-part, room temperature vulcanizing adhesive suitable for the environment and materials installed. Use adhesive on NEMA 4 or NEMA 4X enclosures only.
- C. Color: White on black background.
- D. Letter Height:
  - 1. Pushbuttons/Selector Switches: 1/8 inch.
  - 2. Other Electrical Equipment: 1/2 inch.

#### 2.04 SIGNS AND LABELS

- A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.
- B. Warning labels for arc flash hazards shall be provided per NEC.

## PART 3 EXECUTION

#### 3.01 GENERAL

- A. Electrical drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.
- B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on the Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.
- C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Keep openings in boxes and equipment closed during construction.
- E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.
- F. Circuit layouts are not intended to show the number of fittings, pullboxes, conduit bodies or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the approved equipment at no additional cost to the Owner.
- G. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement or equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

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- H. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by 1/2-inch spacers to provide a clearance between wall and equipment.
- I. All floor mounted electrical equipment shall be placed on 4-inch thick (3/4-inch, 45-degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.
- J. The Contractor shall harmonize the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the Contractor without additional expense to the Owner. In case interference develops, the Engineer is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.
- K. Raceways and conductors for, switches, receptacles, and other miscellaneous low voltage power and signal system as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Homeruns, as shown on the Drawings, are to assist the Contractor in identifying raceways to be run exposed and raceways to be run concealed. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in all process spaces. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with fans, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.
- L. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- M. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.
- N. Based on the results of arc-flash calculations performed as specified in Section 26 05 70, Electrical Systems Analysis, provide appropriate warning labels on all electrical equipment.

#### 3.02 ANCHORING, BRACING, AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for Project design criteria provided in Section 01 61 00, Common Product Requirements, to meet the requirements of Section 01 88 15, Anchorage and Bracing.

#### 3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

- A. Drawings show each homerun circuit to be provided. Do not combine power or control circuits into common raceways without authorization of Engineer.
- B. Homerun circuits shown on the Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:
  - 1. Analog control circuits from devices in same general area to same destination.
    - a. No power or ac discrete control circuits shall be combined in same conduit with analog circuits.
    - b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, paging system circuits shall be combined with power or Class 1 circuits.
    - c. Analog circuits shall be continuous from source to destination. Do not add TJB, splice, or combine into a multi-pair cable without authorization of Engineer.
    - d. Raceways shall not exceed 40 percent.
    - e. Changes shall be documented on record drawings.
  - 2. Discrete control circuits from devices in the same general area to the same destination.
    - a. No power or analog control circuits shall be combined in same conduit with discrete circuits.
    - b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
    - c. Raceways shall not exceed 40 percent.
    - d. Changes shall be documented on record drawings.
  - 3. Power circuits from loads in same general area to same source location (such as: panelboard, switchboard, low voltage motor control center).
    - a. Lighting Circuits: Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
    - b. Receptacle Circuits, 120 Volt Only: Combine no more than three circuits to a single raceway. Provide a separate neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.

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c. All Other Power Circuits: Do not combine power circuits without authorization of Engineer.

## 3.04 NAMEPLATES, SIGNS, AND LABELS

- A. Arc Flash Protection Warning Signs:
  - 1. Field mark automatic transfer switches, switchgear, switchboards, motor control centers, adjustable frequency drives and panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
  - 2. Use arc flash hazard boundary, energy level, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis as basis for warning signs.
- B. Available Fault Current Signs:
  - 1. Install label on service equipment to indicate the maximum available fault current at the equipment. Labels shall be of sufficient durability for the environment in which the equipment is installed. Labels shall include the following information:
    - a. Equipment name or identification.
    - b. Available fault current at the equipment.
    - c. Date the fault current calculations were performed.
  - 2. Use bolted fault current and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for the label.
  - 3. Where existing electrical systems are modified, completely remove existing fault current labels if present, and install new labels in accordance with the above requirements.
- C. Multiple Power Supply Sign: Install permanent plaque or directory at each service disconnect location denoting other services, feeders, and branch circuits supplying the building, and the area served by each.
- D. Equipment Nameplates:
  - 1. Provide a nameplate to label electrical equipment including automatic transfer switch, switchgear, switchboards, motor control centers, adjustable frequency drives, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
  - 2. Automatic transfer switches, Switchgear, motor control center, adjustable frequency drives, transformer, and terminal junction box nameplates shall include equipment designation.

- 3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
- 4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

## 3.05 LOAD BALANCE

- A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.
- B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.
- C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

## 3.06 CLEANING AND TOUCHUP PAINTING

- A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.
- B. Touchup Paint:
  - 1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
  - 2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

#### 3.07 PROTECTION FOLLOWING INSTALLATION

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.
- B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

#### 3.08 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain Shop Drawings and templates from equipment vendors or other subcontractors and locate the concealed conduits before the floor slab is poured.
- C. Where setting the Drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installation of such conduits to be exposed. Request for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetrations and slots as specified in Section 26 05 33, Raceway and Boxes.

#### 3.09 CUTTING AND PATCHING

- A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete.
- B. Core drill holes in existing concrete floors and wall as required.
- C. Install work at such time as to require the minimum amount of cutting and patching.
- D. Do not cut joists, beams, girders, columns, or any other structural members.
- E. Cut openings only large enough to allow easy installation of the conduit.
- F. Patching to be of the same kind and quality of material as was removed.
- G. The completed patching work shall restore the surface to its original appearance or better.
- H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- I. Remove rubble and excess patching materials from the premises.
- J. When existing conduits are cut at the floor line, they shall be filled with grout of suitable patching material.

## 3.10 CHECKOUT AND STARTUP

## A. Voltage Field Test:

- 1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
- 2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
- 3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
  - a. Submit Voltage Field Test Report within 5 days of test.
- 4. Unbalance Corrections:
  - a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
  - b. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.
- B. Equipment Line Current Tests:
  - 1. Check line current in each phase for each piece of equipment.
  - 2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
  - 3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken

# **END OF SECTION**

## SECTION 26 05 04 BASIC ELECTRICAL MATERIALS AND METHODS

# PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
    - b. E814, Method of Fire Tests of Through-Penetration Fire Stops.
  - 2. Canadian Standards Association (CSA).
  - 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
  - 4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
  - 5. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - b. C12.1, Code for Electricity Metering.
    - c. C12.6, Phase-Shifting Devices Used in Metering, Marking and Arrangement of Terminals.
    - d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
    - e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
    - f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
  - 6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 7. UL:
    - a. 98, Standard for Enclosed and Dead-Front Switches.
    - b. 248, Standard for Low Voltage Fuses.
    - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
    - d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
    - e. 508, Standard for Industrial Control Equipment.
    - f. 810, Standard for Capacitors.
    - g. 943, Standard for Ground-Fault Circuit-Interrupters.

- h. 1059, Standard for Terminal Blocks.
- i. 1479, Fire Tests of Through-Penetration Fire Stops.

#### 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Provide manufacturers' data for the following:
    - a. Control devices.
    - b. Control relays.
    - c. Circuit breakers.
    - d. Fused switches.
    - e. Non-fused switches.
    - f. Timers.
    - g. Fuses.
    - h. Magnetic contactors.
    - i. Intrinsic safety barriers.
    - j. Power Panels.
    - k. Distribution panelboard.
    - l. Panelboards.
    - m. Transformers.
    - n. Stand-alone motor starter.
    - o. Raceways.
    - p. Conductors.
    - q. Pull and Junction Boxes.
    - r. Control Components.
    - s. Test procedures and testing results.

## 1.03 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:
  - 1. Fuses, 0 Volt to 600 Volts: Six of each type and each current rating installed.
  - 2. Items as specified in Low Voltage Switchgear.

#### PART 2 PRODUCTS

# 2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

- A. General:
  - 1. Type: Molded case.
  - 2. Trip Ratings: 15 amps to 1200 amps.

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- 3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
- 4. Suitable for mounting and operating in any position.
- 5. UL 489.
- 6. Electronic trip as shown on the Drawings.
- B. Operating Mechanism:
  - 1. Overcenter, trip-free, toggle type handle.
  - 2. Quick-make, quick-break action.
  - 3. Locking provisions for padlocking breaker in OPEN position.
  - 4. ON/OFF and TRIPPED indicating positions of operating handle.
  - 5. Operating handle to assume a CENTER position when tripped.
- C. Trip Mechanism:
  - 1. Individual permanent thermal and magnetic trip elements in each pole.
  - 2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
  - 3. Two and three pole, common trip.
  - 4. Automatically opens all poles when overcurrent occurs on one pole.
  - 5. Test button on cover.
  - 6. Calibrated for 40 degrees C ambient, unless shown otherwise.
  - 7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.
- D. Short Circuit Interrupting Ratings:
  - 1. Equal to, or greater than, available fault current or interrupting rating shown.
  - 2. Equal to rating of existing equipment.
- E. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.
- F. Connections:
  - 1. Supply (line side) at either end.
  - 2. Mechanical wire lugs, except crimp compression lugs where shown.
  - 3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
  - 4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
  - 5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.

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- G. Enclosures for Independent Mounting:
  - 1. See Article Enclosures.
  - 2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
  - 3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

## 2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

- A. UL 98 listed for use and location of installation.
- B. NEMA KS 1.
- C. Short Circuit Rating: 200,000 amps rms symmetrical with Class R, Class J, or Class L fuses installed.
- D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- E. Connections:
  - 1. Mechanical lugs, except crimp compression lugs where shown.
  - 2. Lugs removable/replaceable.
  - 3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.
- F. Fuse Provisions:
  - 1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
  - 2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.
- G. Enclosures: See Article Enclosures.
- H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

#### 2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

- A. NEMA KS 1.
- B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

- C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.
- D. Enclosures: See Article Enclosures.
- E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

#### 2.04 FUSE, 250-VOLT AND 600-VOLT

- A. Power Distribution, General:
  - 1. Current-limiting, with 200,000 ampere rms interrupting rating.
  - 2. Provide to fit mountings specified with switches.
  - 3. UL 248.
- B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:
  - 1. Class: RK-1.
  - 2. Type: Dual element, with time delay.
  - 3. Manufacturers and Products:
    - a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
    - b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).
- C. Power Distribution, Ampere Ratings 601 Amps to 6,000 Amps:
  - 1. Class: L.
  - 2. Double O-rings and silver links.
  - 3. Manufacturers and Products:
    - a. Bussmann; Type KRP-C.
    - b. Littelfuse, Inc.; Type KLPC.
- D. Cable Limiters:
  - 1. 600V or less; crimp to copper cable, bolt to bus or terminal pad.
  - 2. Manufacturer and Product: Bussmann; K Series.
- E. Ferrule:
  - 1. 600V or less, rated for applied voltage, small dimension.
  - 2. Ampere Ratings: 1/10 amp to 30 amps.
  - 3. Dual-element time-delay, time-delay, or nontime-delay as required.
  - 4. Provide with blocks or holders as indicated and suitable for location and use.
  - 5. Manufacturers:
    - a. Bussmann.
    - b. Littlefuse, Inc.

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#### 2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

- A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.
- B. Selector Switch Operating Lever: Standard.
- C. Indicating Light: Push-to-test.
- D. Pushbutton Color:
  - 1. ON or START: Green.
  - 2. OFF or STOP: Red.
- E. Pushbutton and selector switch lockable in OFF position where indicated.
- F. Legend Plate:
  - 1. Material: Aluminum.
  - 2. Engraving: Enamel filled in high contrasting color.
  - 3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
  - 4. Letter Height: 7/64 inch.
- G. Manufacturers and Products:
  - 1. Heavy-Duty, Oil-Tight Type:
    - a. Allen Bradley; Type 800T.
    - b. Square D Co.; Type T.
  - 2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
    - a. Allen Bradley; Type 800H.
    - b. Square D Co.; Type SK.

#### 2.06 TERMINAL BLOCK, 600 VOLTS

- A. UL 486E and UL 1059.
- B. Size components to allow insertion of necessary wire sizes.
- C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.
- D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
- E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

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- F. Yoke shall guide all strands of wire into terminal.
- G. Current bar shall ensure vibration-proof connection.
- H. Terminals:
  - 1. Capable of wire connections without special preparation other than stripping.
  - 2. Capable of jumper installation with no loss of terminal or rail space.
  - 3. Individual, rail mounted.
- I. Marking system, allowing use of preprinted or field-marked tags.
- J. Manufacturers:
  - 1. Allen-Bradley
  - 2. Square D
  - 3. Weidmuller, Inc.

#### 2.07 MAGNETIC CONTROL RELAY

- A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.
- B. NEMA ICS 2, Designation: A600 (600 volts).
- C. Time Delay Relay Attachment:
  - 1. Pneumatic type, timer adjustable as shown.
  - 2. Field convertible from ON delay to OFF delay and vice versa.
- D. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.
- E. Manufacturers and Products:
  - 1. Square D.
  - 2. "Or-Equal" Approved.

## 2.08 TIME DELAY RELAY

- A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.
- B. NEMA ICS 2 Designation: B150 (150 volts).
- C. Solid-state electronic.

- D. One normally open and one normally closed contact (minimum).
- E. Repeat accuracy plus or minus 2 percent.
- F. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on the Drawings.
- G. Manufacturers and Products:
  - 1. Allen Bradley; Type 700HT.
  - 2. Square D Co.; Type XO.
  - 3. "Or-Equal" Approved.

#### 2.09 RESET TIMER

- A. Drive: Synchronous motor, solenoid-operated clutch.
- B. Mounting: Semiflush panel.
- C. Contacts: 10 amps, 120 volts.
- D. Manufacturers and Products:
  - 1. Eagle Signal Controls; Bulletin 125.
  - 2. Automatic Timing and Controls; Bulletin 305.

## 2.10 ELAPSED TIME METER

- A. Drive: Synchronous motor.
- B. Range: 0 hour to 99,999.9 hours, nonreset type.
- C. Mounting: Semiflush panel.
- D. Manufacturers and Products:
  - 1. General Electric Co.; Type 240, 2-1/2-inch Big Look.
  - 2. Eagle Signal Controls; Bulletin 705.

#### 2.11 MAGNETIC CONTACTOR

- A. UL listed.
- B. Electrically operated, electrically held.

- C. Main Contacts:
  - 1. Power driven in one direction with mechanical spring dropout.
  - 2. Silver alloy with wiping action and arc quenchers.
  - 3. Continuous-duty, rated as shown.
  - 4. Poles: As shown.
- D. Auxiliary Contacts: Rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.
- E. Enclosures: See Article Enclosures.
- F. Manufacturers and Products:
  - 1. Square D Co.; Class 8910.
  - 2. "Or-Equal" Approved.

## 2.12 PHASE MONITOR RELAY

- A. Features:
  - 1. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.
  - 2. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.
  - 3. Adjustable trip and time delay settings.
  - 4. Transient Protection: 1,000V ac.
  - 5. Mounting: Multipin plug-in socket base.
- B. Manufacturer and Product: Automatic Timing and Controls; SLD Series, Type A

#### 2.13 MAGNETIC LIGHTING CONTACTOR

- A. Comply with NEMA ICS 2; provide UL 508 listing.
- B. Electrically operated by dual-acting, single coil mechanism.
- C. Main Contacts:
  - 1. Double-break, continuous-duty, rated refer to the Drawings as applicable.
  - 2. Marked for electric discharge lamps, tungsten, and general purpose loads.
  - 3. Position not dependent on gravity, hooks, latches, or semipermanent magnets.

- 4. Capable of operating in any position.
- 5. Visual indication for each contact.
- D. Provision for remote pilot lamp with use of auxiliary contacts.
- E. Clamp type, self-rising terminal plates for solderless connections.
- F. Enclosures: See Article Enclosures.
- G. Manufacturers and Products: Square D; refer to the Drawings for model.

#### 2.14 SUPPORT AND FRAMING CHANNELS

- A. Stainless Steel Framing Channel: Rolled, Type 316 stainless steel, 12-gauge minimum.
- B. Extruded Aluminum Framing Channel:
  - 1. Material: Extruded from Type 6063-T6 aluminum alloy.
  - 2. Fittings fabricated from Alloy 5052-H32.
- C. Manufacturers:
  - 1. B-Line Systems, Inc.
  - 2. Unistrut Corp.
  - 3. Aickinstrut.

#### 2.15 INTRINSIC SAFETY BARRIER

- A. Provides a safe energy level for exposed wiring in a Class I, Division 1 or Division 2 hazardous area when circuit is connected to power source in nonhazardous area.
- B. Rating: Power source shall be rated 24 volts dc, nominal, with not more than 250 volts available under fault conditions.
- C. Contact Rating: 5 amps, 250 volts ac.
- D. Mounting: Rail or surface.
- E. Manufacturers and Products:
  - 1. MTL, Inc.; Series 2000 or Series 3000.
  - 2. R. Stahl, Inc.

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# 2.16 SWITCHBOARD MATTING

- A. Provide matting having a breakdown of 20 kV minimum.
- B. Manufacturer: U.S. Mat and Rubber Company.

# 2.17 FIRESTOPS

- A. General:
  - 1. Provide UL 1479 classified hourly fire rating equal to, or greater than, the assembly penetrated.
  - 2. Prevent the passage of cold smoke, toxic fumes, and water before and after exposure to flame.
  - 3. Sealants and accessories shall have fire-resistance ratings as established by testing identical assemblies in accordance with ASTM E814, by UL, or other testing and inspection agency acceptable to authorities having jurisdiction.
- B. Firestop System:
  - 1. Formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
  - 2. Fill, Void, or Cavity Material: 3M Brand Fire Barrier Caulk CP25, Putty 303, Wrap/Strip FS195, Composite Sheet CS195 and Penetration Sealing Systems 7902 and 7904 Series.
  - 3. Two-Part, Foamed-In-Place, Silicone Sealant: Dow Corning Corp. Fire Stop Foam, General Electric Co. Pensil 851.
  - 4. Fire Stop Devices: See Section 26 05 33, Raceway and Boxes, for raceway and cable fittings.

## 2.18 ENCLOSURES

- A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.
- B. Color:
  - 1. Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.
  - 2. Outdoor Enclosures to be painted white.
- C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

- D. Enclosure Selections:
  - 1. Except as shown otherwise, provide electrical enclosures according to the following table:

Enclosures					
Location	Finish	Environment	NEMA 250 Type		
Indoor	Finished	Dry	1		
Indoor	Unfinished	Dry	1		
Indoor	Unfinished	Industrial Use	12		
Indoor and Outdoor	Any	Wet	4X 316 Stainless Steel		
Indoor and Outdoor	Any	Denoted "WP"	3R		
Indoor and Outdoor	Any	Wet and Corrosive	4X 316 Stainless Steel		

## PART 3 EXECUTION

- 3.01 GENERAL
  - A. Install equipment in accordance with manufacturer's recommendations.

## 3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

- A. Install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, unless otherwise shown.
- B. Install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas, unless otherwise shown.

#### 3.03 SUPPORT AND FRAMING CHANNEL

- A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.
- B. Channel Type:
  - 1. Interior, Wet or Dry (Noncorrosive) Locations: Stainless steel all locations.
  - 2. Exterior Locations: Stainless steel in all locations epoxy or acrylic paint.

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# 3.04 INTRINSIC SAFETY BARRIERS

- A. Install in compliance with ISA RP12.06.01.
- B. Arrange conductors such that wiring from hazardous areas cannot short to wiring from nonhazardous area.
- C. Stencil "INTRINSICALLY SAFE CIRCUIT" on all boxes enclosing barriers.

## 3.05 SWITCHBOARD MATTING

- A. Install 36-inch width at switchgear, switchboard, motor control centers, and panelboards.
- B. Matting shall run full length of all sides of equipment that have operator controls or afford access to devices.

#### 3.06 FIRESTOPS

- A. Install in strict conformance with manufacturer's instructions. Comply with installation requirements established by testing and inspecting agency.
- B. Sealant: Install sealant including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs.

# **END OF SECTION**

## SECTION 26 05 05 CONDUCTORS

# PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
  - 2. ASTM International (ASTM):
    - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    - b. B3, Standard Specification for Soft or Annealed Copper Wire.
    - c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
    - d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
  - 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV Through 500 kV.
    - b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
    - c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500000 V.
  - 4. Insulated Cable Engineer's Association, Inc. (ICEA):
    - a. S-58-679, Standard for Control Cable Conductor Identification.
    - b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
    - c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
  - 5. National Electrical Manufacturers' Association (NEMA):
    - a. CC 1, Electric Power Connectors for Substations.
    - b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
    - c. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
    - d. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.
    - e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

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- 6. National Fire Protection Association (NFPA):
  - a. 70, National Electrical Code (NEC).
  - b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- 7. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
- 8. UL:
  - a. 13, Standard for Safety for Power-Limited Circuit Cables.
  - b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
  - c. 62, Standard for Safety for Flexible Cord and Cables.
  - d. 486A-486B, Standard for Safety for Wire Connectors.
  - e. 486C, Standard for Safety for Splicing Wire Connectors.
  - f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
  - g. 854, Standard for Safety for Service-Entrance Cables.
  - h. 1072, Standard for Safety for Medium-Voltage Power Cables.
  - i. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
  - j. 1569, Standard for Safety for Metal-Clad Cables.
  - k. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

#### 1.02 SUBMITTALS

2.

- A. Action Submittals:
  - 1. Product Data:
    - a. Wire and cable.
    - b. Wire and cable accessories.
    - Manufactured Wire Systems:
      - a. Product data.
    - b. Rating information.
    - c. Dimensional drawings.
    - d. Special fittings.
  - 3. Busway:
    - a. Product data.
    - b. Rating information.
    - c. Dimensional drawings.
    - d. Special fitting.
    - e. Equipment interface information for equipment to be connected to busways.

- 4. Cable Pulling Calculations:
  - a. Ensure submitted and reviewed before cable installation.
  - b. Provide for the following cable installations:
    - 1) Medium voltage cable runs that cannot be hand pulled.
    - 2) Multiconductor 600-volt cable sizes larger than 2 AWG that cannot be hand pulled.
    - 3) Power and control conductor, and control and instrumentation cable installations in ductbanks.
    - 4) Feeder circuits; single conductors No. 4/0 and larger.
- B. Informational Submittals:
  - 1. Journeyman lineman or electrician splicing credentials.
  - 2. Certified Factory Test Report for conductors 600 volts and below.
  - 3. Certified Factory Test Report per AEIC CS 8, including AEIC qualification report for conductors above 600 volts.
  - 4. Testing requirements as specified in other parts of this section.

## 1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
  - 1. Provide the Work in accordance with NFPA 70. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
  - 2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.
- B. Terminations and Splices for Conductors above 600 Volts: Work shall be done by journeyman lineman with splicing credentials or electrician certified to use materials approved for cable splices and terminations.

## PART 2 PRODUCTS

- 2.01 CONDUCTORS 600 VOLTS AND BELOW
  - A. Conform to applicable requirements of NEMA WC 70.
  - B. Conductor Type: All conductors are to be XHHW-2 stranded Cooper 90 degree insulation.

- C. Flexible Cords and Cables:
  - 1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
  - 2. Conform to physical and minimum thickness requirements of NEMA WC 70.
- D. A submittal is required for the Busway.

#### 2.02 VARIABLE FREQUENCY DRIVES CABLES TO MOTOR

- A. All motors fed from adjustable frequency drives shall utilize a special cable designed to reduce the adverse effects of harmonics / noise, reflective current, and destructive motor bearing currents rated for 1600V or greater.
- B. The cable shall include a continuous copper armor to provide a return path for high frequency currents shall consist of three symmetrical copper ground conductors as well as three phase conductors. The phase conductors shall be compressed stranded copper conductors surrounded by XLP insulation.
- C. Cable shall have an outer XLPE jacket. The jacket shall be impervious to moisture, liquids, and gases, and be listed for submersion.
- D. Conductor shall be rated for continuous operation at 90 degrees C wet or dry.
- E. Size raceways to accommodate the larger size variable frequency drive cable.
- F. Manufacturer: Southwire or approved equal.

#### 2.03 600-VOLT RATED CABLE

- A. General:
  - 1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
  - 2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
  - 3. Suitable for installation in open air, in cable trays, or conduit.
  - 4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
  - 5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil resistant.

- B. Type 1, Multiconductor Control Cable:
  - 1. Conductors:
    - a. 14 AWG, seven-strand copper.
    - b. Insulation: 15-mil PVC with 4-mil nylon.
    - c. UL 1581 listed as Type THHN/THWN rated VW-1.
    - d. Conductor group bound with spiral wrap of barrier tape.
    - e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
  - 2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
  - 3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

- 4. Manufacturers:
  - a. Okonite Co.
  - b. Southwire.
- C. Type 3, 18 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
  - 1. Outer Jacket: 45-mil nominal thickness.
  - 2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
  - 3. Dimension: 0.31-inch nominal OD.
  - 4. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    - b. 20 AWG, seven-strand tinned copper drain wire.
    - c. Insulation: 15-mil nominal PVC.
    - d. Jacket: 4-mil nominal nylon.
    - e. Color Code: Pair conductors, black and red.

- 5. Manufacturers:
  - a. Okonite Co.
  - b. Alpha Wire Corp.
  - c. Belden.
- D. Type 4, 18 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.
  - 1. Outer Jacket: 45-mil nominal.
  - 2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
  - 3. Dimension: 0.32-inch nominal OD.
  - 4. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    - b. 20 AWG, seven-strand, tinned copper drain wire.
    - c. Insulation: 15-mil nominal PVC.
    - d. Jacket: 4-mil nylon.
    - e. Color Code: Triad conductors black, red, and blue.
  - 5. Manufacturers:
    - a. Okonite Co.
    - b. Alpha Wire Corp.
    - c. Belden.
- E. Type 5, 18 AWG, Multitwisted Shielded Pairs, with a Common Overall Shield, Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 57 requirements.
  - 1. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
    - b. Tinned copper drain wires.
    - c. Pair drain wire size AWG 20; group drain wire size AWG 18.
    - d. Insulation: 15-mil PVC.
    - e. Jacket: 4-mil nylon.
    - f. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
    - g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
  - 2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
| Number of Pairs | Maximum Outside<br>Diameter<br>(Inches) | Nominal Jacket<br>Thickness<br>(Mils) |
|-----------------|---|---------------------------------------|
| 4               | 0.50                                    | 45                                    |
| 8               | 0.68                                    | 60                                    |
| 12              | 0.82                                    | 60                                    |
| 16              | 0.95                                    | 80                                    |
| 24              | 1.16                                    | 80                                    |
| 36              | 1.33                                    | 80                                    |
| 50              | 1.56                                    | 80                                    |

3. Cable Sizes:

- 4. Manufacturers:
  - a. Okonite Co.
  - b. Alpha Wire Corp.
  - c. Belden.
- F. Type 6, 18 AWG, Multitwisted Pairs with Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 57.
  - 1. Conductors:
    - a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
    - b. Tinned copper drain wire size AWG 18.
    - c. Insulation: 15-mil nominal PVC.
    - d. Jacket: 4-mil nylon.
    - e. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
  - 2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

Cable Sizes: Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.48	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.10	80
36	1.21	80
50	1.50	80

- 3. Manufacturers:
  - a. Okonite Co.
  - b. Alpha Wire Corp.
  - c. Belden.

### 2.04 GROUNDING CONDUCTORS

- A. Equipment: Stranded copper with green, Type THHN/THWN, insulation.
- B. Direct Buried: Tin plated bare stranded copper.

## 2.05 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

- A. Tape:
  - General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
  - 2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
  - 3. Arc and Fireproofing:
    - a. 30-mil, elastomer.
    - b. Manufacturers and Products:
      - 1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      - 2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

#### B. Identification Devices:

- 1. Sleeve:
  - a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
  - b. Manufacturers and Products:
    - 1) Raychem; Type D-SCE or ZH-SCE.
    - 2) Brady, Type 3PS.
- 2. Heat Bond Marker:
  - a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
  - b. Self-laminating protective shield over text.
  - c. Machine printed black text.
  - d. Manufacturer and Product: 3M Co.; Type SCS-HB.
- 3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
- 4. Tie-On Cable Marker Tags:
  - a. Chemical-resistant white tag.
  - b. Size: 1/2 inch by 2 inches.
  - c. Manufacturer and Product: Raychem; Type CM-SCE.

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- 5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.
- C. Connectors and Terminations:
  - 1. Nylon, Self-Insulated Crimp Connectors:
    - a. Manufacturers and Products:
      - 1) Thomas & Betts; Sta-Kon.
      - 2) Burndy; Insulug.
      - 3) ILSCO.
  - 2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
    - a. Suitable for use with 75 degrees C wire at full NFPA 70,
      - 75 degrees C ampacity.
    - b. Seamless.
    - c. Manufacturers and Products:
      - 1) Thomas & Betts; Sta-Kon.
      - 2) Burndy; Insulink.
      - 3) ILSCO; ILSCONS.
  - 3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
    - a. UL 486C.
    - b. Plated steel, square wire springs.
    - c. Manufacturers and Products:
      - 1) Thomas & Betts.
      - 2) Ideal; Twister.
  - 4. Self-Insulated, Set Screw Wire Connector:
    - a. Two-piece compression type with set screw in brass barrel.
    - b. Insulated by insulator cap screwed over brass barrel.
    - c. Manufacturers:
      - 1) 3M Co.
      - 2) Thomas & Betts.
      - 3) Marrette.
- D. Cable Lugs:
  - 1. In accordance with NEMA CC 1.
  - 2. Rated 600 volts of same material as conductor metal.
  - 3. Uninsulated Crimp Connectors and Terminators:
    - a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
    - b. Manufacturers and Products:
      - 1) Thomas & Betts; Color-Keyed.
      - 2) Burndy; Hydent.
      - 3) ILSCO.

- 4. Uninsulated, Bolted, Two-Way Connectors and Terminators:a. Manufacturers and Products:
  - 1) Thomas & Betts; Locktite.
  - 2) Burndy; Quiklug.
  - 3) ILSCO.

### E. Cable Ties:

- 1. Nylon, adjustable, self-locking, and reusable.
- 2. Manufacturer and Product: Thomas & Betts; TY-RAP.
- F. Heat Shrinkable Insulation:
  - 1. Thermally stabilized cross-linked polyolefin.
  - 2. Single wall for insulation and strain relief.
  - 3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
  - 4. Manufacturers and Products:
    - a. Thomas & Betts; SHRINK-KON.
    - b. Raychem; RNF-100 and ES-2000.

#### 2.06 PULLING COMPOUND

- A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.
- B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.
- C. Approved for intended use by cable manufacturer.
- D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.
- E. Manufacturers:
  - 1. Ideal Co.
  - 2. Polywater, Inc.
  - 3. Cable Grip Co.

#### 2.07 WARNING TAPE

A. As specified in Section 26 05 33, Raceway and Boxes.

#### 2.08 SOURCE QUALITY CONTROL

- A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.
- B. Conductors Above 600 Volts: Test in accordance with NEMA WC 71 and AEIC CS 8 partial discharge level test for EPR insulated cable.

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## PART 3 EXECUTION

#### 3.01 GENERAL

- A. Conductor installation shall be in accordance with manufacturer's recommendations.
- B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.
- C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- D. Terminate conductors and cables, unless otherwise indicated.
- E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.
- F. Cable Lugs: Provide with correct number of holes, bolt size, and center-tocenter spacing as required by equipment terminals.
- G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.
- H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.
- I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

#### 3.02 POWER CONDUCTOR COLOR CODING

- A. Conductors 600 Volts and Below:
  - 1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
  - 2. 8 AWG and Smaller: Provide colored conductors.

3. Colors:

System	Conductor	Color		
All Systems	Equipment Grounding	Green		
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red		
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue		
240/120 Volts, Three-Phase, Four-Wire, Delta, Center Tap, Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue		
480Y/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow		
NOTE: Phase A, B, C implies direction of positive phase rotation.				

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

## 3.03 CIRCUIT IDENTIFICATION

- A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
- B. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.
- C. Circuits Not Appearing in Circuit Schedules:
  - 1. Assign circuit name based on device or equipment at load end of circuit.
  - 2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

## D. Method:

- 1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
- 2. Cables and Conductors 2 AWG and Larger:
  - a. Identify with marker plates or tie-on cable marker tags.
  - b. Attach with nylon tie cord.
- 3. Taped-on markers or tags relying on adhesives not permitted.

## 3.04 CONDUCTORS 600 VOLTS AND BELOW

- A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.
- B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.
- C. Connections and Terminations:
  - 1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
  - 2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
  - 3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
  - 4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
  - 5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
  - 6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
  - 7. Place no more than one conductor in any single-barrel pressure connection.
  - 8. Install crimp connectors with tools approved by connector manufacturer.
  - 9. Install terminals and connectors acceptable for type of material used.
  - 10. Compression Lugs:
    - a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    - b. Do not use plier type crimpers.
- D. Do not use soldered mechanical joints.

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- E. Splices and Terminations:
  - 1. Insulate uninsulated connections.
  - 2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
  - 3. Outdoors, Dry Locations: Use flame retardant, cold- and weatherresistant tape or single wall heat shrink.
  - 4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.
- F. Cap spare conductors with UL listed end caps.
- G. Cabinets, Panels, and Motor Control Centers:
  - 1. Remove surplus wire, bridle and secure.
  - 2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
- H. Control and Instrumentation Wiring:
  - 1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
  - 2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
  - 3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
  - 4. Cable Protection:
    - a. Under Infinite Access Floors: May install without bundling.
    - b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2 inch in diameter.
    - c. Maintain integrity of shielding of instrumentation cables.
    - d. Ensure grounds do not occur because of damage to jacket over shield.
- I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

#### 3.05 TESTING:

A. All testing shall be completed per NETA standard procedures. All testing of conductors shall include High Potential Testing, Meg Ohm Testing, as well as the recommended manufacturers test requirements of the conductor manufacturer.

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- B. Test shall be completed by an independent third-party testing form certified by NETA.
- C. The qualifications of the testing firm and the personnel completing the onsite test shall be submitted to the Engineer for review and approval 60 days prior to the commencement of any onsite testing.
- D. The procedure of all test and the method or recording and submitted test results shall be submitted to the Engineer for review prior to the commencement of any testing.

# **END OF SECTION**

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

## PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
  - 2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

## 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Product data for the following:
      - 1) Exothermic weld connectors.
        - 2) Mechanical connectors.
        - 3) Compression connectors.
        - 4) Specialty tools.

## 1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
  - 1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
  - 2. Materials and equipment manufactured within the scope of standards published by UL:
    - a. Confirm conformance with UL standards.
    - b. Supply with an applied UL listing mark.

### PART 2 PRODUCTS

#### 2.01 GROUND ROD

- A. Material: Copper-clad.
- B. Diameter: Minimum 3/4 inch.
- C. Length: 20 feet.

#### 2.02 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

#### 2.03 CONNECTORS

- A. Exothermic Weld Type:
  - 1. Outdoor Weld: Suitable for exposure to elements or direct burial.
  - 2. Indoor Weld: Use low-smoke, low-emission process.
  - 3. Manufacturers:
    - a. Erico Products, Inc.
    - b. Thermoweld.
- B. Compression Type:
  - 1. Compress-deforming type; wrought copper extrusion material.
  - 2. Single indentation for conductors 6 AWG and smaller.
  - 3. Double indentation with extended barrel for conductors 4 AWG and larger.
  - 4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
  - 5. Manufacturers:
    - a. Burndy Corp.; Hyground Irreversible Compression.
    - b. Thomas and Betts Co.
    - c. ILSCO.
- C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
  - 1. Manufacturers:
    - a. Burndy Corp.
    - b. Thomas and Betts Co.

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS 26 05 26 - 2

### 2.04 GROUNDING WELLS

- A. H-20 rated Ground rod box complete with cast-iron riser ring and traffic rated cover marked "GROUND ROD".
- B. Manufacturers and Products:
  - 1. Christy Co.
  - 2. Lightning and Grounding Systems, Inc.

# PART 3 EXECUTION

- 3.01 GENERAL
  - A. All main grounding and bonding conductors shall be exothermic welded at ground rods in wet location, interior locations and at points where new or existing conductors are extended.
  - B. All grounding or bonding conductors terminated at equipment shall terminate in manufacturers supplied terminals.
  - C. Grounding: In compliance with NFPA 70 and IEEE C2.
  - D. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.
  - E. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.
  - F. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.
  - G. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
  - H. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.
  - I. Shielded Instrumentation Cables:
    - 1. Ground shield to ground bus at power supply for analog signal.
    - 2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
    - 3. Do not ground instrumentation cable shield at more than one point.

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#### SWF BAF IMPROVEMENTS

#### 3.02 WIRE CONNECTIONS

- A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.
- B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
- C. Connect ground conductors to raceway grounding bushings.
- D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.
- E. Connect enclosure of equipment containing ground bus to that bus.
- F. Bolt connections to equipment ground bus.
- G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.
- H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.
- I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

#### 3.03 MOTOR GROUNDING

- A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.
- B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
- C. Motors Less Than 10 hp: Use furnished ground lug in motor connection box. If none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.
- D. Motors 10 hp and Above: Use furnished ground lug in motor connection box. If none furnished, tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing. Install solderless terminal with minimum 5/16-inch diameter bolt.

### 3.04 GROUND RODS

- A. Install full length with conductor connection at upper end.
- B. Install with connection point below finished grade, unless otherwise shown.
- C. Space multiple ground rods by one rod length.
- D. Install to 8 feet below local frost depth.

### 3.05 GROUNDING WELLS

- A. Install for ground rods located inside buildings, asphalt and paved areas, and where shown on the Drawings.
- B. Install riser ring and cover flush with surface.
- C. Place 6 inches of crushed rock in bottom of each well.

### 3.06 CONNECTIONS

- A. General:
  - 1. Abovegrade Connections: Install exothermic weld.
  - 2. Belowgrade Connections: Install exothermic weld.
  - 3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
  - 4. Notify Engineer prior to backfilling ground connections.
- B. Exothermic Weld Type:
  - 1. Wire brush or file contact point to bare metal surface.
  - 2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
  - 3. Avoid using badly worn molds.
  - 4. Mold to be completely filled with metal when making welds.
  - 5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

## 3.07 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

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- B. Bond electrical equipment supported by metal platforms to the platforms.
- C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

### 3.08 MANHOLE AND HANDHOLE GROUNDING

- A. Install one ground rod inside each manhole and handhole larger than 24-inch by 24-inch inside dimensions.
- B. Ground Rod Floor Protrusion: 4 inches to 6 inches above floor.
- C. Make connections of grounding conductors fully visible and accessible.
- D. Connect all noncurrent-carrying metal parts and any metallic raceway grounding bushings to ground rod with 6 AWG copper conductor.

#### 3.09 TRANSFORMER GROUNDING

- A. Bond neutrals of transformers within buildings to system ground network and to any additional indicated grounding electrodes.
- B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.
- C. Bond neutrals of pad-mounted transformers to locally driven ground rods and buried ground wire encircling transformer and system ground network.

## 3.10 LIGHTNING PROTECTION SYSTEMS

A. Bond lightning protection system ground terminals to building or structure grounding electrode system.

## 3.11 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

# **END OF SECTION**

## SECTION 26 05 33 RACEWAY AND BOXES

## PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
  - 2. ASTM International (ASTM):
    - a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
    - b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    - c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    - d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
    - e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
  - 3. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
  - 4. National Electrical Contractor's Association, Inc. (NECA): Installation standards.
  - 5. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - b. C80.1, Electrical Rigid Steel Conduit (ERSC).
    - c. C80.3, Steel Electrical Metallic Tubing (EMT).
    - d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
    - e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
    - f. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
    - g. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
    - h. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
    - i. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
    - j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
    - k. VE 1, Metallic Cable Tray Systems.

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- 6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
- 7. UL:
  - a. 1, Standard for Safety for Flexible Metal Conduit.
  - b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
  - c. 6, Standard for Safety for Electrical Rigid Metal Conduit Steel.
  - d. 6A, Standard for Safety for Electrical Rigid Metal Conduit Aluminum, Red Brass and Stainless.
  - e. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
  - f. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
  - g. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
  - h. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
  - i. 797, Standard for Safety for Electrical Metallic Tubing Steel.
  - j. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
  - k. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
  - 1. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
  - m. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
  - n. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.
- B. Action Submittals:
  - 1. Manufacturer's Literature:
    - a. Rigid aluminum conduit.
    - b. PVC Schedule 40 conduit.
    - c. Conduit fittings.
    - d. Wireways.
    - e. Surface metal raceway.
    - f. Device boxes for use in hazardous areas.
    - g. Junction and pull boxes used at or below grade.
    - h. Large junction and pull boxes.
    - i. Terminal junction boxes.
  - 2. Precast Manholes and Handholes:
    - a. Dimensional drawings and descriptive literature.
    - b. Traffic loading calculations.
    - c. Accessory information.

- 3. Conduit Layout:
  - a. Provide drawings for underground and concealed conduits including, but not limited to ductbanks, under floor slabs, concealed in floor slabs, and concealed in walls.
  - b. Provide plan and section showing arrangement and location of conduit and duct bank required for:
    - 1) Low and medium voltage feeder and branch circuits.
    - 2) Instrumentation and control systems.
    - 3) Communications systems.
    - 4) Empty conduit for future use.
  - c. Electronic CAD; scale not greater than 1 inch equals 20 feet.

## 1.02 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
  - 1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
  - 2. Materials and equipment manufactured within scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

## PART 2 PRODUCTS

## 2.01 CONDUIT AND TUBING

- A. Rigid Aluminum Conduit:
  - 1. Meet requirements of NEMA C80.5 and UL 6A.
  - 2. Material: Type 6063, copper-free aluminum alloy.
- B. PVC-Coated Rigid Aluminum Conduit:
  - 1. Meet requirements of NEMA RN 1.
  - 2. Material:
    - a. Type 6063, copper-free aluminum alloy.
    - b. Meet requirements of NEMA C80.5 and UL 6A.
    - c. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
    - d. Interior Finish: Urethane coating, 2-mil nominal thickness.
  - 3. Threads: Factory coated with urethane.
  - 4. Bendable without damage to interior or exterior coating.

- C. PVC Schedule 40 Conduit:
  - 1. Meet requirements of NEMA TC 2 and UL 651.
  - 2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

### 2.02 FITTINGS

- A. Rigid Aluminum Conduit:
  - 1. General:
    - a. Meet requirements of UL 514B.
    - b. Type: Threaded, copper-free. Set screw fittings not permitted.
  - 2. Insulated Bushing:
    - a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
    - b. Manufacturer and Product: O-Z/Gedney; Type AB.
  - 3. Grounding Bushing:
    - a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
    - b. Manufacturer and Product: O-Z/Gedney; Type ABLG.
  - 4. Conduit Hub:
    - a. Material: Cast aluminum, with insulated throat.
    - b. UL listed for use in wet locations.
    - c. Manufacturers and Products:
      - 1) O-Z/Gedney; Type CHA.
      - 2) Thomas & Betts; Series 370AL.
      - 3) Meyers; Series SA.
  - 5. Conduit Bodies:
    - a. Manufacturers and Products (For Normal Conditions):
      - 1) Appleton; Form 85 threaded unilets.
      - 2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      - 3) Killark; Series O electrolets.
    - b. Manufacturers (For Hazardous Locations):
      - 1) Appleton.
      - 2) Crouse-Hinds.
      - 3) Killark.
  - 6. Couplings: As supplied by conduit manufacturer.
  - 7. Conduit Sealing Fitting:
    - a. Manufacturers and Products:
      - 1) Appleton; Type EYF-AL or Type EYM-AL.
      - 2) Crouse-Hinds; Type EYS-SA or Type EZS-SA.
      - 3) Killark; Type EY or Type EYS.

- 8. Drain Seal:
  - a. Manufacturers and Products:
    - 1) Appleton; Type EYDM-A.
    - 2) Crouse-Hinds; Type EYD-SA or Type EZD-SA.
- 9. Drain/Breather Fitting:
  - a. Manufacturers and Products:
    - 1) Appleton; Type ECDB.
    - 2) Crouse-Hinds; ECD.
- 10. Expansion Fitting:

a.

- Manufacturers and Products:
  - 1) Deflection/Expansion Movement: Steel City; Type DF-A.
  - 2) Expansion Movement Only: Steel City; Type AF-A.
- 11. Cable Sealing Fittings:
  - a. To form watertight nonslip cord or cable connection to conduit.
  - b. Bushing: Neoprene at connector entry.
  - c. Manufacturer and Product: Appleton; CG-S.
- B. PVC Conduit and Tubing:
  - 1. Meet requirements of NEMA TC 3.
  - 2. Type: PVC, slip-on.

#### 2.03 JUNCTION AND PULL BOXES

- A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.
- B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.
- C. Large Sheet Steel Box:
  - 1. NEMA 250, Type 1.
  - 2. Box: Code-gauge, galvanized steel.
  - 3. Cover: Full access, screw type.
  - 4. Machine Screws: Corrosion-resistant.
- D. Large Stainless Steel Box:
  - 1. NEMA 250 Type 4X and 316.
  - 2. Box: 14-gauge, ASTM A240/A240M, Type 316 stainless steel, with white enamel painted interior mounting panel.
  - 3. Cover: Hinged with clamps.
  - 4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
  - 5. Manufacturers:
    - a. Hoffman Engineering Co.

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- b. Robroy Industries.
- c. Wiegman.

#### 2.04 SURFACE METAL RACEWAY

- A. General:
  - 1. Meet requirements of UL 5.
  - 2. Material: Two-piece, code-gauge steel.
  - 3. Finish: Factory applied rust inhibiting primer and gray semi-gloss finish suitable for field painting.
  - 4. Configuration: Single, 1-17/32-inch by 2-3/4 inch section, unless otherwise indicated.
- B. Fittings and Accessories:
  - 1. Wire clips at 30 inches on center.
  - 2. Coupling, cover clips, supporting clips, ground clamps, and elbows as required; to comply with manufacturer's recommendations.
  - 3. Manufacturers:
    - a. The Wiremold Co.
    - b. Walker.

#### 2.05 METAL WIREWAYS

- A. Meet requirements of UL 870.
- B. Type: Aluminum-enclosed, lay-in type.
- C. Cover: Removable, screw type.
- D. Rating: indoor.
- E. Finish: Rust inhibiting phosphatizing primer and gray baked enamel.
- F. Hardware: Plated to prevent corrosion; screws installed toward the inside protected by springs nuts or otherwise guarded to prevent wire insulation damage.
- G. Knockouts: without knockouts, unless otherwise indicated.
- H. Manufacturers:
  - 1. Hoffman.
  - 2. Panduit.
  - 3. Square D.
  - 4. Eaton.

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### 2.06 PRECAST MANHOLES AND HANDHOLES

- A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.
- B. Loading: AASHTO, H-20 in accordance with ASTM C857.
- C. Access: Provide cast concrete 6-inch or 12-inch risers between top of manhole and finished grade at required elevations.
- D. Drainage:
  - 1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
  - 2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and a minimum 4-inch outlet and outlet pipe.
- E. Raceway Entrances:
  - 1. Provide on all four sides.
  - 2. Provide knockout panels or precast individual raceway openings.
  - 3. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.
- F. Embedded Pulling Iron:
  - 1. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.
  - 2. Location:
    - a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
    - b. Floor: Centered below manhole or handhole cover.
- G. Cable Racks:
  - 1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
  - 2. Wall Attachment:
    - a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
    - b. Insert Spacing: Maximum 3 feet on center for inside perimeter of manhole.
    - c. Arrange in order that spare raceway ends are clear for future cable installation.

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- H. Manhole Frames and Covers:
  - 1. Material: Machined cast iron.
  - 2. Diameter: 36 inch.
  - 3. Cover Type: Indented, solid top design, with two drop handles each.
  - 4. Cover Loading: AASHTO H-20.
  - 5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
    - a. Above 600 Volts: ELECTRIC HV.
    - b. 600 Volts and Below: ELECTRIC LV.
    - c. TELEPHONE.
- I. Handhole Frames and Covers:
  - 1. Material: Steel, hot-dipped galvanized.
  - 2. Cover Type: Solid, torsion spring, of diamond nonskid design.
  - 3. Cover Loading: AASHTO H-20.
  - 4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
    - a. 600 Volts and Below: ELECTRIC LV.
    - b. TELEPHONE.
- J. Hardware: Steel, hot-dip galvanized.
- K. Furnish knockout for ground rod in each hand hole and manhole.
- L. Manufacturers:
  - 1. Utility Vault Co.
  - 2. Penn-Cast Products, Inc.
  - 3. Concrete Conduit Co.
  - 4. Associated Concrete Products, Inc.
  - 5. Pipe, Inc.

#### 2.07 ACCESSORIES

- A. Duct Bank Spacers:
  - 1. Modular Type:
    - a. Nonmetallic, interlocking, for multiple conduit sizes.
    - b. Suitable for all types of conduit.
    - c. Manufacturers:
      - 1) Underground Device, Inc.
      - 2) Carlon.

- 2. Template Type:
  - a. Nonmetallic, custom made one-piece spacers.
  - b. Suitable for all types of conduit.
  - c. Material: HDPE or polypropylene, 1/2-inch minimum thickness.
  - d. Conduit openings cut 1 inch larger than conduit outside diameter.
  - e. Additional openings for stake-down, rebar, and concrete flow through as required.
  - f. Manufacturer and Product: SP Products; Quik Duct.
- B. Identification Devices:
  - 1. Raceway Tags:
    - a. Material: Permanent, polyethylene.
    - b. Shape: Round.
    - c. Raceway Designation: Pressure stamped, embossed, or engraved.
    - d. Tags relying on adhesives or taped-on markers not permitted.
  - 2. Warning Tape:
    - a. Material: Polyethylene, 4-mil gauge with detectable strip.
    - b. Color: Red.
    - c. Width: Minimum 6 inches.
    - d. Designation: Warning on tape that electric circuit is located below tape.
    - e. Identifying Letters: Minimum 1-inch-high permanent black lettering imprinted continuously over entire length.
    - f. Manufacturers and Products:
      - 1) Panduit; Type HTDU.
      - 2) Reef Industries; Terra Tape.
  - 3. Buried Raceway Marker:
    - a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
    - b. Designation: Engrave to depth of 3/32 inch; ELECTRIC CABLES, in letters 1/4-inch high.
    - c. Minimum Dimension: 1/4 inch thick, 10 inches long, and 3/4 inch wide.
- C. Heat Shrinkable Tubing:
  - 1. Material: Heat-shrinkable, cross-linked polyolefin.
  - 2. Semi-flexible with meltable adhesive inner liner.
  - 3. Color: Black.
  - 4. Manufacturers:
    - a. Raychem.
    - b. 3M.

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- D. Wraparound Duct Band:
  - 1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hotmelt adhesive.
  - 2. Width: 50 mm minimum.
  - 3. Manufacturer and Product: Raychem; Type TWDB.

### PART 3 EXECUTION

- 3.01 GENERAL
  - A. Conduit and tubing sizes shown are based on use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.
  - B. Comply with NECA Installation Standards.
  - C. Crushed or deformed raceways not permitted.
  - D. Maintain raceway entirely free of obstructions and moisture.
  - E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
  - F. Aluminum Conduit: Do not install in direct contact with concrete. Install in PVC sleeve or cored hole through concrete walls and slabs.
  - G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
  - H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
  - I. Group raceways installed in same area.
  - J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.
  - K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
  - L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
  - M. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.

- N. Install watertight fittings in outdoor, underground, or wet locations.
- O. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
- P. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
- Q. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.
- R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
- S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
- T. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

#### 3.02 REUSE OF EXISTING CONDUITS

- A. Where the Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria.
  - 1. Conduit is in useable condition with no deformation, corrosion, or damage to exterior surface.
  - 2. Conduit is sized per the NEC.
  - 3. Conduit is of the type specified in Contract Documents.
  - 4. Conduit is supported as specified in Contract Documents.
- B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4 inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

#### 3.03 CONDUIT APPLICATION

- A. Diameter: Minimum 3/4.
- B. Exterior, Exposed: Rigid aluminum.
- C. Interior, Exposed: Rigid aluminum.
- D. Direct Earth Burial: PVC Schedule 40.
- E. Concrete-Encased Ductbank: PVC Schedule 40.

- F. Separate conduits for analog signals and data communications cables from conduits for power conductors and cables in parallel runs by a minimum of 12 inches.
- G. Separate conduits for discrete signals cables from conduits for power conductors and cables in parallel runs over 50 feet by a minimum of 6 inches.
- H. Separate conduits for VFD cables from other conduits in parallel runs by a minimum of 12 inches.

### 3.04 FLEXIBLE CONNECTIONS

- A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:
  - 1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
  - 2. Conduit Size Over 4 Inches: Nonflexible.
  - 3. Wet or Corrosive Areas: Flexible, nonmetallic liquid-tight.
  - 4. Dry Areas: Flexible, metallic liquid-tight.
  - 5. Hazardous Areas: Flexible coupling suitable for Class I, Division 1 and 2 areas.
- B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.
- C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.
- D. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

#### 3.05 PENETRATIONS

- A. Make at right angles, unless otherwise shown.
- B. Notching or penetration of structural members, including footings and beams, not permitted.
- C. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating as specified in Section 26 05 04, Basic Electrical Materials and Methods.

- D. Apply heat shrinkable tubing or single layer of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.
- E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.
- F. Entering Structures:
  - 1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
  - 2. Concrete Roof or Membrane Waterproofed Wall or Floor:
    - a. Provide a watertight seal.
    - b. Without Concrete Encasement: Install watertight entrance seal device on each side.
    - c. With Concrete Encasement: Install watertight entrance seal device on accessible side.
    - d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
    - e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner. Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
    - f. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
  - 3. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
  - 4. Manholes and Handholes:
    - a. Metallic Raceways: Provide insulated grounding bushings.
    - b. Nonmetallic Raceways: Provide bell ends flush with wall.
    - c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

#### 3.06 SUPPORT

- A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 10 feet in any application. Do not support from piping, pipe supports, or other raceways.
- B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.
- C. Application/Type of Conduit Strap:
  - 1. Aluminum Conduit: Aluminum or stainless steel.

- D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
  - 1. Wood: Wood screws.
  - 2. Hollow Masonry Units: Toggle bolts.
  - 3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
  - 4. Steelwork: Machine screws.
  - 5. Location/Type of Hardware:
    - a. Wet, Noncorrosive Areas: Stainless steel.
    - b. Corrosive Areas: Stainless steel.
- E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.
- F. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

#### 3.07 BENDS

- A. Install concealed raceways with a minimum of bends in the shortest practical distance.
- B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
- C. Install with symmetrical bends or cast metal fittings.
- D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
- E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
- F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.
- G. PVC Conduit:
  - 1. Bends 30 Degrees and Larger: Provide factory-made elbows.
  - 2. Use manufacturer's recommended method for forming smaller bends.
- H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

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## 3.08 PVC CONDUIT

- A. Solvent Welding:
  - 1. Apply manufacturer recommended solvent to joints.
  - 2. Install in order that joint is watertight.

## B. Adapters:

- 1. PVC to Metallic Fittings: PVC terminal type.
- 2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.
- C. Belled-End Conduit: Bevel unbelled end of joint prior to joining.

## 3.09 RIGID ALUMINUM CONDUIT

- A. Install in accordance with manufacturer's instructions.
- B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.
- C. Provide PVC boot to cover exposed threading.

## 3.10 TERMINATION AT ENCLOSURES

- A. Cast Metal Enclosure: Install manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
- B. Nonmetallic, Cabinets, and Enclosures:
  - 1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
  - 2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.
- C. Sheet Metal Boxes, Cabinets, and Enclosures:
  - 1. General:
    - a. Install insulated bushing on ends of conduit where grounding is not required.
    - b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
    - c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
    - d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.

- e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
- 2. Aluminum Conduit:
  - a. Provide one lock nut each on inside and outside of enclosure.
  - b. Install grounding bushing at source enclosure.
  - c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
- 3. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.
- D. Motor Control Center, Switchboard, and Switchgear:
  - 1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
  - 2. Terminate PVC conduit entering bottom with bell end fittings.

### 3.11 UNDERGROUND RACEWAYS

- A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
- B. Cover: Maintain minimum one 2-foot cover above concrete encasement, unless otherwise shown.
- C. Make routing changes as necessary to avoid obstructions or conflicts.
- D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
- E. Union type fittings not permitted.
- F. Spacers:
  - 1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
  - 2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
- G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.
- H. Transition from Underground to Exposed: PVC-Coated Aluminum conduit.

- I. Installation with Other Piping Systems:
  - 1. Crossings: Maintain minimum 12-inch vertical separation.
  - 2. Parallel Runs: Maintain minimum 12-inch separation.
  - 3. Installation over valves or couplings not permitted.
- J. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.
- K. Provide expansion/deflection fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.
- L. Concrete Encasement:
  - 1. As specified in Section 03 30 10, Structural Concrete.
  - 2. Concrete Color: Red.
- M. Backfill:
  - 1. As specified in Section 31 23 23.15, Trench Backfill. Backfill material to within 12 inches of surface.
  - 2. Do not backfill until inspected by Engineer.

# 3.12 OUTLET AND DEVICE BOXES

- A. General:
  - 1. Install plumb and level.
  - 2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
  - 3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
  - 4. Install galvanized mounting hardware in industrial areas.
- B. Size:
  - 1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
    - a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
  - 2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
  - 3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

- C. Locations:
  - 1. Drawing locations are approximate.
  - 2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.
  - 3. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.
- D. Mounting Height:
  - 1. General:
    - a. Dimensions given to centerline of box.
    - b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
    - c. Do not straddle CMU block or other construction joints.
  - 2. Light Switch:

3.

- a. 48 inches above floor.
- b. When located next to door, install on lock side of door.
- Thermostat: 54 inches above floor.
- 4. Telephone Outlet:
  - a. 15 inches above floor.
  - b. 6 inches above counter tops.
  - c. Wall Mounted: 52 inches above floor.
- 5. Convenience Receptacle:
  - a. General Interior Areas: 15 inches above floor.
  - b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of backsplash, or 6 inches above counter tops without backsplash.
  - c. Industrial Areas, Workshops: 48 inches above floor.
  - d. Outdoor Areas: 24 inches above finished grade.
- 6. Special-Purpose Receptacle: 48 inches above floor or as shown.
- 7. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on the Drawings.
- E. Flush Mounted:
  - 1. Install with concealed conduit.
  - 2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
  - 3. Holes in surrounding surface shall be no larger than required to receive box.
- F. Supports:
  - 1. Support boxes independently of conduit by attachment to building structure or structural member.

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- 2. Install bar hangers in frame construction or fasten boxes directly as follows:
  - a. Wood: Wood screws.
  - b. Concrete or Brick: Bolts and expansion shields.
  - c. Hollow Masonry Units: Toggle bolts.
  - d. Steelwork: Machine screws.
- 3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
- 4. Provide plaster rings where necessary.
- 5. Boxes embedded in concrete or masonry need not be additionally supported.
- G. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.
- H. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

## 3.13 JUNCTION AND PULL BOXES

- A. General:
  - 1. Install plumb and level.
  - 2. Installed boxes shall be accessible.
  - 3. Do not install on finished surfaces.
  - 4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
  - 5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
  - 6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
  - 7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
  - 8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.
- B. Flush Mounted:
  - 1. Install with concealed conduit.
  - 2. Holes in surrounding surface shall be no larger than required to receive box.
  - 3. Make edges of boxes flush with final surface.

- C. Mounting Hardware:
  - 1. Noncorrosive Dry Areas: Galvanized.
  - 2. Noncorrosive Wet Areas: Stainless steel.
  - 3. Corrosive Areas: Stainless steel.

## D. Supports:

- 1. Support boxes independently of conduit by attachment to building structure or structural member.
- 2. Install bar hangers in frame construction or fasten boxes directly as follows:
  - a. Wood: Stainless Steel screws.
  - b. Concrete or Brick: Bolts and expansion shields, Stainless Steel.
  - c. Hollow Masonry Units: Toggle bolts, Stainless Steel.
  - d. Steelwork: Stainless Steel Machine screws.
- 3. Stainless steel threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
- 4. Boxes embedded in concrete or masonry need not be additionally supported.
- E. At or Below Grade:
  - 1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
  - 2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
  - 3. Obtain Engineer's Owner's written acceptance prior to installation in paved areas, roadways, or walkways.
  - 4. Use boxes and covers suitable to support anticipated weights.

## 3.14 MANHOLES AND HANDHOLES

- A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.
- B. Do not install until final raceway grading has been determined.
- C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.
- D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.
- E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.
# 3.15 EMPTY RACEWAYS

- A. Provide permanent, removable cap over each end.
- B. Provide PVC plug with pull tab for underground raceways with end bells.
- C. Provide nylon pull cord.
- D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

## 3.16 IDENTIFICATION DEVICES

- A. Raceway Tags:
  - 1. Identify origin and destination.
  - 2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
  - 3. Install tags at each terminus for concealed raceways.
  - 4. Provide nylon strap for attachment.
- B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of run.
- C. Buried Raceway Marker:
  - 1. Install at grade to indicate direction of underground raceway.
  - 2. Install at bends and at intervals not exceeding 100 feet in straight runs.
  - 3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

# 3.17 PROTECTION OF INSTALLED WORK

- A. Protect products from effects of moisture, corrosion, and physical damage during construction.
- B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.
- C. Touch up painted conduit threads after assembly to cover nicks or scars.
- D. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

# **END OF SECTION**

# SECTION 26 05 70 ELECTRICAL SYSTEMS ANALYSIS

# PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American National Standards Institute (ANSI).
  - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
    - b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
    - c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
    - d. 1584, Guide for Performing Arc Flash Hazard Calculations.
  - 3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
  - 4. National Fire Protection Association (NFPA):
    - a. 70, National Electrical Code (NEC).
    - b. 70E, Standard for Electrical Safety in the Workplace.
  - 5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

# 1.02 SUBMITTALS

- A. Action Submittals Signed and Sealed by Professional Engineer (PE) registered in the state of Florida:
  - 1. Short circuit study.
  - 2. Protective Device Coordination Study: Submit within 90 days after approval of short circuit study.
  - 3. Arc Flash Study: Submit initial study with protective Device Coordination Study. Submit final study prior to equipment energization.
  - 4. Arc flash warning labels; submit sample with initial study.
  - 5. Electronic files on thumb drive of final studies including all engineering software input files, output reports, and libraries.

# 1.03 QUALITY ASSURANCE

A. Short circuit and protective device coordination and arc flash studies shall be prepared by manufacturer furnishing the major electrical equipment or a professional engineer (PE) registered in the State of Florida.

B. The short circuit, protective device coordination and arc flash studies shall be signed and sealed by a professional engineer (PE) registered in the State of Florida.

## 1.04 SEQUENCING AND SCHEDULING

- A. Initial complete short circuit, protective device coordination and arc-flash studies shall be submitted and reviewed before Engineer will review Shop Drawings for overcurrent protective equipment. It is imperative that the electrical subcontractor begin this work immediately after award of the contract. This task requires extensive coordination and work with numerous Vendors. Failure of the electrical subcontractor to provide the initial complete short circuit study before any Shop Drawing for any overcurrent protective equipment will result in rejection of the Shop Drawing without review.
- B. Revised short circuit, protective device coordination, and arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.
- C. Final short circuit, protective device coordination, and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as-installed equipment, materials, and parameter data or settings entered into equipment based on study.
- D. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

### 1.05 GENERAL STUDY REQUIREMENTS

- A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on the Drawings.
- B. Short circuit, protective device coordination and arc-flash studies shall be performed as a minimum on the following pieces of equipment:
  - 1. New Breakers in existing Switchboard.
  - 2. New Distribution Panelboard.
  - 3. Disconnects Switches.
  - 4. Adjustable Frequency Drives.
  - 5. Branch Circuit Panelboards.
- C. Perform studies using one of the following electrical engineering software packages:
  - 1. SKM Power Tools for Windows.
  - 2. ETAP.

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- D. Perform complete fault calculations for each existing and proposed source combination.
  - 1. Source combination may include present and future power company supply circuits, large motors, or generators.
- E. Utilize proposed and existing load data for study obtained from Contract Documents, Owner as-built drawings, and from field investigation of system configuration, wiring information, and equipment.
- F. Existing System and Equipment:
  - 1. All of existing system elements shall be included in study.
  - 2. Include fault contribution of existing motors and equipment in study.
  - 3. Include impedance elements for new and existing system and equipment.
  - 4. Include protective devices in series with new equipment.
- G. Device coordination time-current curves for medium and low voltage distribution system; include individual protective device time-current characteristics.

## 1.06 SHORT CIRCUIT STUDY

- A. General:
  - 1. Prepare in accordance with IEEE 399.
  - 2. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
  - 3. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
  - 4. Use cable and bus resistances calculated at 25 degrees C.
  - 5. Use medium-voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation levels.
  - 6. Use 600-volt cable reactances based on use of typical dimensions of XHHW conductors.
  - 7. Use transformer impedances 92.5 percent of "nominal" impedance based on tolerances specified in IEEE C57.12.00.
- B. Provide:
  - 1. Calculation methods and assumptions.
  - 2. Typical calculation.
  - 3. Tabulations of calculated quantities.
  - 4. Results, conclusions, and recommendations.
  - 5. Selected base per unit quantities.

- 6. One-line diagrams.
- 7. Source impedance data, including electric utility system and motor fault contribution characteristics.
- 8. Impedance diagrams.
- 9. Zero-sequence impedance diagrams.
- C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:
  - 1. Electric utility's supply termination point.
  - 2. Automatic transfer switches.
  - 3. Low-voltage switchgear and switchboards.
  - 4. Motor control centers.
  - 5. Standby and Emergency generators.
  - 6. Branch circuit panelboards.
  - 7. All Adjustable Frequency Drives.
  - 8. All disconnect switches.
  - 9. Future load contributions as shown on one-line diagram.
- D. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.
- E. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.
- F. Verify:
  - 1. Equipment and protective devices are applied within their ratings.
  - 2. Adequacy of switchgear and switchboard and motor control centers bus bars to withstand short circuit stresses.
  - 3. Adequacy of transformer windings to withstand short circuit stresses.
  - 4. Cable and busway sizes for ability to withstand short circuit heating, in addition to normal load currents.
- G. Tabulations:
  - 1. General Data:
    - a. Short circuit reactances of rotating machines.
    - b. Cable and conduit material data.
    - c. Bus data.
    - d. Transformer data.
    - e. Circuit resistance and reactance values.
  - 2. Short Circuit Data (for each source combination):
    - a. Fault impedances.
    - b. X to R ratios.
    - c. Asymmetry factors.

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- d. Motor contributions.
- e. Short circuit kVA.
- f. Symmetrical and asymmetrical fault currents.
- 3. Equipment Evaluation:
  - a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
  - b. Maximum fault current available.
- H. Written Summary:
  - 1. Scope of studies performed.
  - 2. Explanation of bus and branch numbering system.
  - 3. Prevailing conditions.
  - 4. Selected equipment deficiencies.
  - 5. Results of short circuit study.
  - 6. Comments or suggestions.
- I. Suggest changes and additions to equipment rating and/or characteristics.
- J. Notify Engineer and Owner in writing of existing circuit protective devices improperly rated for new fault conditions.
- K. Revise data for "as-installed" condition.

# 1.07 PROTECTIVE DEVICE COORDINATION STUDY

- A. General:
  - 1. Prepare in accordance with IEEE 242.
  - 2. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.
    - a. Provide separate curve sheets for phase and ground fault coordination for each scenario.
    - b. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet. Limit number of devices shown to four to six.
    - c. Identify device associated with each curve by manufacturer type, function, and, if applicable, recommended tap, time delay, instantaneous and other settings recommended.
    - d. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
    - e. Apply motor protection methods that comply with NFPA 70.

### SWF BAF IMPROVEMENTS

- B. Plot Characteristics on Curve Sheets:
  - 1. Electric utility's relays.
  - 2. Electric utility's fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
  - 3. Medium-voltage equipment relays.
  - 4. Medium-voltage and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
  - 5. Low-voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
  - 6. Pertinent transformer full-load currents at 100 percent.
  - 7. Transformer magnetizing inrush currents.
  - 8. Transformer damage curves; appropriate for system operation and location.
  - 9. ANSI transformer withstand parameters.
  - 10. Significant symmetrical and asymmetrical fault currents.
  - 11. Motor overload relay settings for motors greater than 40 hp.
  - 12. Ground fault protective device settings.
  - 13. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.
- C. Primary Protective Device Settings for Delta-Wye Connected Transformer:
  - 1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within transformer's characteristics curve, including a point equal to 58 percent of IEEE C57.12.00 withstand point.
  - 2. Secondary Line-to-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.
- D. Separate medium voltage relay characteristics curves from curves for other devices by at least 0.4-second time margin.
- E. Tabulate Recommended Protective Device Settings:
  - 1. Relays:
    - a. Current tap.
    - b. Time dial.
    - c. Instantaneous pickup.
    - d. Electronic settings data file.
  - 2. Circuit Breakers:
    - a. Adjustable pickups.
    - b. Adjustable time-current characteristics.
    - c. Adjustable time delays.
    - d. Adjustable instantaneous pickups.

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- e.  $I^2t$  In/Out.
- f. Zone interlocking.
- g. Electronic settings data file.
- F. Written Summary:
  - 1. Scope of studies performed.
  - 2. Summary of protective device coordination methodology.
  - 3. Prevailing conditions.
  - 4. Selected equipment deficiencies.
  - 5. Results of coordination study.
  - 6. Appendix of complete relay and circuit breaker electronic setting files submit electronic data files from manufacturer's software.
  - 7. Comments or suggestions.

## 1.08 ARC FLASH STUDY

- A. Perform arc flash hazard study after short circuit and protective device coordination study has been completed, reviewed and accepted.
- B. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.
- C. Base Calculation: For each major part of electrical power system, determine the following:
  - 1. Flash hazard protection boundary.
  - 2. Limited approach boundary.
  - 3. Restricted approach boundary.
  - 4. Incident energy level.
- D. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.
  - 1. Bus name.
  - 2. Bus voltage.
- E. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:
  - 1. Bus name.
  - 2. Upstream protective device name, type, and settings.
  - 3. Bus line-to-line voltage.

- F. Produce arc flash evaluation summary sheet listing the following additional items:
  - 1. Bus name.
  - 2. Upstream protective device name, type, settings.
  - 3. Bus line-to-line voltage.
  - 4. Bus bolted fault.
  - 5. Protective device bolted fault current.
  - 6. Arcing fault current.
  - 7. Protective device trip/delay time.
  - 8. Breaker opening time.
  - 9. Solidly grounded column.
  - 10. Equipment type.
  - 11. Gap.
  - 12. Arc flash boundary.
  - 13. Working distance.
  - 14. Incident energy.
- G. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 40 cal/cm<sup>2</sup>. Propose approaches to reduce energy levels.
- H. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:
  - 1. Equipment manufacturer's information used to prepare study.
  - 2. Assumptions made during study.
  - 3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
  - 4. Arc flash evaluations summary spreadsheet.
  - 5. Bus detail sheets.
  - 6. Arc flash warning labels printed in color on thermally bonded adhesive backed UV and weather-resistant labels.

# PART 2 PRODUCTS

### 2.01 ARC FLASH WARNING LABELS

A. Arc flash warning labels printed in color on thermally bonded adhesive backed, UV- and weather-resistant labels. An example label is located following end of section in Figure 1.

# PART 3 EXECUTION

## 3.01 GENERAL

- A. Adjust relay and protective device settings according to values established by coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Engineer in writing of required major equipment modifications.
- D. Provide laminated one-line diagrams (minimum size 11 inches by 17 inches) to post on interior of electrical room doors.
- E. Provide arc flash warning labels on equipment as specified in this section.

# 3.02 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification:
  - 1. Figure 1: Example Arc Flash Label.

# **END OF SECTION**

**WARNING** 

SHOCK AND ARC FLASH HAZARD: APPROPRIATE PPE REQUIRED, ONLY QUALIFIED PERSONS MAY PERFORM ENERGIZED WORK ON THIS EQUIPMENT

SHOCK HAZARD		ARC FLASH HAZARD			Incident Energy	
480 VAC	With Cover Removed	18 in	Working Distance		0.13 cal/cm <sup>2</sup>	
42 in	Limited Approach	5 in	Arc Flash Boundary			
12 in	Restricted Approach				0.10	
4PX1					@ Working Distance	
00	Glove Class					
3.24 kA	Bus Bolted Fault					
ID:	439172					
WARNING: This label is valid for five years after Label Date. Changes to equipment, settings or system configuration will invalidate this information.				Labe 15 Se	el Date ep 2014	Label <b># 0009-Line</b>

Figure 1

Example Arc Flash Label

## SECTION 26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS

# PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. D877/D877M, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
    - b. D923, Standard Practices for Sampling Electrical Insulating Liquids.
    - c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
    - d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
    - e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
    - f. D1298, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
    - g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
    - h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
    - i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
    - j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
  - 2. Institute of Electrical and Electronics Engineers (IEEE):
    - a. 43, Recommended Practice for Testing Insulation Resistance of Electric Machinery.
    - b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
    - c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
    - d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.

- e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
- f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
- g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
- h. C2, National Electrical Safety Code.
- i. C37.20.1, Standard for Metal-Enclosed Low-Voltage (1,000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
- j. C37.20.2, Standard for Metal-Clad Switchgear.
- k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
- 1. C37.23, Standard for Metal-Enclosed Bus.
- m. C62.33, Standard Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components.
- 3. Insulated Cable Engineers Association (ICEA):
  - a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
  - b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
  - c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
- 4. National Electrical Manufacturers Association (NEMA):
  - a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
  - b. PB 2, Deadfront Distribution Switchboards.
  - c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
- 5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- 6. National Fire Protection Association (NFPA):
  - a. 70, National Electrical Code (NEC).
  - b. 70B, Recommended Practice for Electrical Equipment Maintenance.
  - c. 70E, Standard for Electrical Safety in the Workplace.
  - d. 101, Life Safety Code.
- 7. National Institute for Certification in Engineering Technologies (NICET).
- 8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

# 1.02 SUBMITTALS

- A. Informational Submittals:
  - 1. Submit 30 days prior to performing inspections or tests:
    - a. Testing firm qualifications.
    - b. Schedule for performing inspection and tests.
    - c. List of references to be used for each test.
    - d. Sample copy of equipment and materials inspection form(s).
    - e. Sample copy of individual device test form.
    - f. Sample copy of individual system test form.
  - 2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
    - a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
    - b. Staged sequence of initial energization of electrical equipment.
    - c. Lock-Out-Tag-Out plan for each stage of the progressive energization.
    - d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
  - 3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
  - 4. Operation and Maintenance Data:
    - a. In accordance with Section 01 78 23, Operation and Maintenance Data.
    - b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
  - 5. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
    - a. Protective relays.
    - b. Intelligent overload relays.
    - c. Adjustable frequency drives.
    - d. Power metering devices.
    - e. Uninterruptible power supplies.
    - f. Electrical communications modules.

### SWF BAF IMPROVEMENTS

## 1.03 QUALITY ASSURANCE

- A. Testing Firm Qualifications:
  - 1. Corporately and financially independent organization functioning as an unbiased testing authority.
  - 2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
  - 3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
  - 4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
  - 5. Technicians certified by NICET or NETA.
  - 6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
  - 7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
  - 8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories.
- B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.
- C. Test Instrument Calibration: In accordance with NETA ATS.

### 1.04 SEQUENCING AND SCHEDULING

- A. Perform inspection and electrical tests after equipment listed herein has been installed.
- B. Perform tests with apparatus de-energized whenever feasible.
  - 1. Scheduled with Engineer prior to de-energization.
  - 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- C. Notify Engineer and Owner at least 24 hours prior to performing tests on energized electrical equipment.

# PART 2 PRODUCTS (NOT USED)

# PART 3 EXECUTION

- 3.01 GENERAL
  - A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.
  - B. Tests and inspections shall establish:
    - 1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
    - 2. Installation operates properly.
    - 3. Equipment is suitable for energization.
    - 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.
  - C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
  - D. Set, test, and calibrate circuit breakers power monitoring meters and other applicable devices in accordance with values established by short circuit, coordination, and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis.
  - E. Adjust mechanisms and moving parts of equipment for free mechanical movement.
  - F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
  - G. Verify nameplate data for conformance to Contract Documents and approved Submittals.
  - H. Realign equipment not properly aligned and correct unlevelness.
  - I. Properly anchor electrical equipment found to be inadequately anchored.
  - J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.
  - K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
  - L. Provide proper lubrication of applicable moving parts.

#### SWF BAF IMPROVEMENTS

- M. Inform Engineer of working clearances not in accordance with NFPA 70.
- N. Investigate and repair or replace:
  - 1. Electrical items that fail tests.
  - 2. Active components not operating in accordance with manufacturer's instructions.
  - 3. Damaged electrical equipment.
- O. Electrical Enclosures:
  - 1. Remove foreign material and moisture from enclosure interior.
  - 2. Vacuum and wipe clean enclosure interior.
  - 3. Remove corrosion found on metal surfaces.
  - 4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
  - 5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
  - 6. Repair or replace improperly operating latching, locking, or interlocking devices.
  - 7. Replace missing or damaged hardware.
  - 8. Finish:
    - a. Provide matching paint and touch up scratches and mars.
    - b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.
- P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

### 3.02 CHECKOUT AND STARTUP

- A. Voltage Field Test:
  - 1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
  - 2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
  - 3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
    - a. Submit Voltage Field Test Report within 5 days of test.
  - 4. Unbalance Corrections:
    - a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.

- b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.
- B. Equipment Line Current Tests:
  - 1. Check line current in each phase for each piece of equipment.
  - 2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
  - 3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

## 3.03 SWITCHBOARD AND MCC ASSEMBLIES

- A. Visual and Mechanical Inspection:
  - 1. Insulator damage and contaminated surfaces.
  - 2. Proper barrier and shutter installation and operation.
  - 3. Proper operation of indicating devices.
  - 4. Improper blockage of air-cooling passages.
  - 5. Proper operation of drawout elements.
  - 6. Integrity and contamination of bus insulation system.
  - 7. Check door and device interlocking system by:
    - a. Closure attempt of device when door is in OFF or OPEN position.
    - b. Opening attempt of door when device is in ON or CLOSED position.
  - 8. Check key interlocking systems for:
    - a. Key captivity when device is in ON or CLOSED position.
    - b. Key removal when device is in ON or CLOSED position.
    - c. Closure attempt of device when key has been removed.
    - d. Correct number of keys in relationship to number of lock cylinders.
    - e. Existence of Other Keys Capable of Operating Lock Cylinders: Destroy duplicate sets of keys.
  - 9. Check nameplates for proper identification of:
    - a. Equipment title and tag number with latest one-line diagram.
      - b. Pushbutton.
      - c. Control switch.
    - d. Pilot light.
    - e. Control relay.
    - f. Circuit breaker.
    - g. Indicating meter.
  - 10. Verify fuse and circuit breaker ratings, sizes, and types conform to those specified.

- 11. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench thermographic survey applied to bolted joints.
  - a. Ohmic value to be zero.
  - b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
  - c. Thermographic survey temperature gradient of 2 degrees C or less.
- 12. Check operation and sequencing of electrical and mechanical interlock systems by:
  - a. Closure attempt for locked open devices.
  - b. Opening attempt for locked closed devices.
  - c. Key exchange to operate devices in OFF-NORMAL positions.
- 13. Verify performance of each control device and feature.
- 14. Control Wiring:
  - a. Compare wiring to local and remote control and protective devices with elementary diagrams.
  - b. Proper conductor lacing and bundling.
  - c. Proper conductor identification.
  - d. Proper conductor lugs and connections.
- 15. Exercise active components.
- 16. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.
- B. Electrical Tests:
  - 1. Insulation Resistance Tests:
    - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    - b. Each phase of each bus section.
    - c. Phase-to-phase and phase-to-ground for 1 minute.
    - d. With breakersopen.
    - e. With breakers closed.
    - f. Control wiring except that connected to solid state components.
    - g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
  - 2. Overpotential Tests:
    - a. Applied ac or dc voltage and test procedure in accordance with IEEE C37.20.1C37.20.2, C37.20.3 and NEMA PB 2.
    - b. Each phase of each bus section.
    - c. Phase-to-phase and phase-to-ground for 1 minute.
    - d. Test results evaluated on a pass/fail basis.

- 3. Current Injection Tests:
  - a. For entire current circuit in each section.
  - b. Secondary injection for current flow of 1 ampere.
  - c. Test current at each device.
- 4. Control Wiring:
  - a. Apply secondary voltage to control power and potential circuits.
  - b. Check voltage levels at each point on terminal boards and each device terminal.
- 5. Operational Test:
  - a. Initiate control devices.
  - b. Check proper operation of control system in each section.

#### 3.04 PANELBOARDS

- A. Visual and Mechanical Inspection: Include the following inspections and related work:
  - 1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
  - 2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
  - 3. Check panelboard mounting, area clearances, and alignment and fit of components.
  - 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
  - 5. Perform visual and mechanical inspection for overcurrent protective devices.
- B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:
  - 1. Insulation Resistance Tests:
    - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    - b. Each phase of each bus section.
    - c. Phase-to-phase and phase-to-ground for 1 minute.
    - d. With breakers open.
    - e. With breakers closed.
    - f. Control wiring except that connected to solid state components.
    - g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
  - 2. Ground continuity test ground bus to system ground.

#### SWF BAF IMPROVEMENTS

### 3.05 DRY TYPE TRANSFORMERS

- A. Visual and Mechanical Inspection:
  - 1. Physical and insulator damage.
  - 2. Proper winding connections.
  - 3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
  - 4. Defective wiring.
  - 5. Proper operation of fans, indicators, and auxiliary devices.
  - 6. Removal of shipping brackets, fixtures, or bracing.
  - 7. Free and properly installed resilient mounts.
  - 8. Cleanliness and improper blockage of ventilation passages.
  - 9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
  - 10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.
- B. Electrical Tests:
  - 1. Insulation Resistance Tests:
    - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      - 1) Winding-to-winding.
      - 2) Winding-to-ground.
    - b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
    - c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
    - d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
    - e. Insulation resistance test results to compare within 1 percent of adjacent windings.
  - 2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

# 3.06 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

- A. Visual and Mechanical Inspection:
  - 1. Inspect each individual exposed power cable No. 6 and larger for:
    - a. Physical damage.
    - b. Proper connections in accordance with single-line diagram.
    - c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

- d. Color coding conformance with specification.
- e. Proper circuit identification.
- 2. Mechanical Connections for:
  - a. Proper lug type for conductor material.
  - b. Proper lug installation.
  - c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
- 3. Shielded Instrumentation Cables for:
  - a. Proper shield grounding.
  - b. Proper terminations.
  - c. Proper circuit identification.
- 4. Control Cables for:
  - a. Proper termination.
  - b. Proper circuit identification.
- 5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.
- B. Electrical Tests for Conductors No. 6 and Larger:
  - 1. Insulation Resistance Tests:
    - a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
    - b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
    - c. Evaluate ohmic values by comparison with conductors of same length and type.
    - d. Investigate values less than 50 megohms.
  - 2. Continuity test by ohmmeter method to ensure proper cable connections.
- C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

### 3.07 METAL ENCLOSED BUSWAYS

- A. Visual and Mechanical Inspection:
  - 1. Inspect for:
    - a. Proper connections.
    - b. Proper bracing, suspension alignment, and enclosure ground.
    - c. Check if orientation of ventilated bus provides proper cooling in accordance with manufacturer's instructions and if ventilation openings are not blocked.
    - d. Proper phase relationship using continuity test.
    - e. Supports at maximum allowable intervals.

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- 2. For busways rated for outdoors, check for:
  - a. Check bus orientation for proper location of breathers or weephole plugs.
  - b. Removal of weep-hole plugs.
  - c. Proper installation of joint shields.
  - d. Proper operation of space heaters.
- B. Electrical Tests:
  - 1. Insulation Resistance Tests:
    - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    - b. Each phase of each bus section.
    - c. Phase-to-phase and phase-to-ground for 1 minute.
    - d. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
  - 2. Overpotential Tests:
    - a. Phase-to-phase and phase-to-ground for 1 minute.
    - b. Test results evaluated on pass/fail basis.
  - 3. Contact Resistance Tests:
    - a. At each uninsulated bus connection.
    - b. On insulated bus, measure resistance of bus section and compare values with adjacent phases.

### 3.08 SAFETY SWITCHES, 600 VOLTS MAXIMUM

- A. Visual and Mechanical Inspection:
  - 1. Proper blade pressure and alignment.
  - 2. Proper operation of switch operating handle.
  - 3. Adequate mechanical support for each fuse.
  - 4. Proper contact-to-contact tightness between fuse clip and fuse.
  - 5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
  - 6. Proper phase barrier material and installation.
  - 7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
  - 8. Perform mechanical operational test and verify mechanical interlocking system operation and sequencing.
- B. Electrical Tests:
  - 1. Insulation Resistance Tests:
    - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

- b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
- c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
- 2. Contact Resistance Tests:
  - a. Contact resistance in microhms across each switch blade and fuse holder.
  - b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

### 3.09 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

- A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.
- B. Visual and Mechanical Inspection:
  - 1. Proper mounting.
  - 2. Proper conductor size.
  - 3. Feeder designation according to nameplate and one-line diagram.
  - 4. Cracked casings.
  - 5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
  - 6. Operate breaker to verify smooth operation.
  - 7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
  - 8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.
- C. Electrical Tests:
  - 1. Insulation Resistance Tests:
    - a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
    - b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
    - c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
    - d. Test values to comply with NETA ATS, Table 100.1.
  - 2. Contact Resistance Tests:
    - a. Contact resistance in microhms across each pole.
    - b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
  - 3. Primary Current Injection Test to Verify:
    - a. Long-time minimum pickup and delay.

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- b. Short-time pickup and delay.
- c. Ground fault pickup and delay.
- d. Instantaneous pickup by run-up or pulse method.
- e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
- f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
- g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

# 3.10 LOW VOLTAGE POWER CIRCUIT BREAKERS

- A. Visual and Mechanical Inspection:
  - 1. Proper mounting, cell fit, and element alignment.
  - 2. Proper operation of racking interlocks.
  - 3. Check for damaged arc chutes.
  - 4. Proper contact condition.
  - 5. Bolt torque level in accordance with NETA ATS, Table 100.12.
  - 6. Perform mechanical operational and contact alignment tests in accordance with manufacturer's instructions.
  - 7. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.
  - 8. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.
  - 9. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.
  - 10. Check operation of electrically operated breakers in accordance with manufacturer's instructions.
  - 11. Check for adequate lubrication on contact, moving, and sliding surfaces.
- B. Electrical Tests:
  - 1. Insulation Resistance Tests:
    - a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
    - b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
    - c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
    - d. Test values to comply with NETA ATS, Table 100.1.

- 2. Contact Resistance Tests:
  - a. Contact resistance in microhms across each pole.
  - b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
- 3. Primary Current Injection Test to Verify:
  - a. Long-time minimum pickup and delay.
  - b. Short-time pickup and delay.
  - c. Ground fault pickup and delay.
  - d. Instantaneous pickup by run-up or pulse method.
  - e. Trip characteristic when adjusted to setting sheet parameters shall be within manufacturer's published time-current tolerance band.

## 3.11 INSTRUMENT TRANSFORMERS

- A. Visual and Mechanical Inspection:
  - 1. Visually check current, potential, and control transformers for:
    - a. Cracked insulation.
    - b. Broken leads or defective wiring.
    - c. Proper connections.
    - d. Adequate clearances between primary and secondary circuit wiring.
  - 2. Verify Mechanically:
    - a. Grounding and shorting connections have good contact.
    - b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
  - 3. Verify proper primary and secondary fuse sizes for potential transformers.
- B. Electrical Tests:
  - 1. Current Transformer Tests:
    - a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
    - b. Polarity test.
    - c. Ratio and accuracy test.
  - 2. Potential Transformer Tests:
    - a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:
      - 1) Winding-to-winding.
      - 2) Winding-to-ground.
    - b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
    - c. Ratio and accuracy test.
  - 3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

### SWF BAF IMPROVEMENTS

### 3.12 GROUNDING SYSTEMS

- A. Visual and Mechanical Inspection:
  - 1. Equipment and circuit grounds in motor control center, panelboard switchboard, and switchgear assemblies for proper connection and tightness.
  - 2. Ground bus connections motor control center, panelboard, switchboard, and switchgear assemblies for proper termination and tightness.
  - 3. Effective transformer core and equipment grounding.
  - 4. Accessible connections to grounding electrodes for proper fit and tightness.
  - 5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.
- B. Electrical Tests:
  - 1. Fall-of-Potential Test:
    - a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
    - b. Main ground electrode system resistance to ground to be no greater than 5 ohm(s).
  - 2. Two-Point Direct Method Test:
    - a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
    - b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.
  - 3. Neutral Bus Isolation:
    - a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
    - b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
    - c. Investigate values less than 50 megohms.

# 3.13 LOW-VOLTAGE STAND-ALONE STARTERS

- A. Visual and Mechanical Inspection:
  - 1. Proper barrier and shutter installation and operation.
  - 2. Proper operation of indicating and monitoring devices.
  - 3. Proper overload protection for each motor.
  - 4. Improper blockage of air-cooling passages.
  - 5. Proper operation of drawout elements.
  - 6. Integrity and contamination of bus insulation system.

- 7. Check door and device interlocking system by:
  - a. Closure attempt of device when door is in OFF or OPEN position.
  - b. Opening attempt of door when device is in ON or CLOSED position.
- 8. Check key interlocking systems for:
  - a. Key captivity when device is in ON or CLOSED position.
  - b. Key removal when device is in OFF or OPEN position.
  - c. Closure attempt of device when key has been removed.
  - d. Correct number of keys in relationship to number of lock cylinders.
  - e. Existence of other keys capable of operating lock cylinders; destroy duplicate sets of keys.
- 9. Check nameplates for proper identification of:
  - a. Equipment title and tag number with latest one-line diagram.
  - b. Pushbuttons.
  - c. Control switches.
  - d. Pilot lights.
  - e. Control relays.
  - f. Circuit breakers.
  - g. Indicating meters.
- 10. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
- 11. Verify current and potential transformer ratios conform to Contract Documents.
- 12. Check bus connections for high resistance by low-resistance ohmmeter, calibrated torque wrench applied to bolted joints and thermographic survey.
- 13. Ohmic value to be zero.
  - a. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
  - b. Thermographic survey temperature gradient of 2 degrees C, or less per NETA ATS, Table 100.18.
- 14. Check operation and sequencing of electrical and mechanical interlock systems by:
  - a. Closure attempt for locked open devices.
  - b. Opening attempt for locked closed devices.
  - c. Key exchange to operate devices in OFF-NORMAL positions.
- 15. Verify performance of each control device and feature furnished as part of motor control center.
- 16. Control Wiring:
  - a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
  - b. Check for proper conductor lacing and bundling.
  - c. Check for proper conductor identification.
  - d. Check for proper conductor lugs and connections.

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- 17. Exercise active components.
- 18. Inspect contactors for:
  - a. Correct mechanical operations.
  - b. Correct contact gap, wipe, alignment, and pressure.
  - c. Correct torque of connections.
- 19. Compare overload heater rating with full-load current for proper size.
- 20. Compare circuit breaker with motor characteristics for proper size.
- 21. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.
- B. Electrical Tests:
  - 1. Insulation Resistance Tests:
    - a. Applied megohimmeter dc voltage in accordance with NETA ATS, Table 100.1.
    - b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
    - c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
    - d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
    - e. Test values to comply with NETA ATS, Table 100.1.
  - 2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
    - a. Trip time in accordance with manufacturer's published data.
    - b. Investigate values in excess of 120 seconds.
  - 3. Control Wiring Tests:
    - a. Apply secondary voltage to control power and potential circuits.
    - b. Check voltage levels at each point on terminal board and each device terminal.
    - c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1 megohm minimum insulation resistance.
  - 4. Operational test by initiating control devices to affect proper operation.

## 3.14 THERMOGRAPHIC SURVEY

- A. Provide thermographic survey per NETA ATS Table 100.18 of connections associated with incoming service conductors, bus work, and branch feeder conductors No. and larger at each:
  - 1. Switchboard.
  - 2. Distribution Panelboard.
  - 3. Branch Panelboard.

- B. Provide thermographic survey of feeder conductors No. 4 and larger terminating at:
  - 1. Low voltage disconnect switches.
- C. Remove necessary enclosure metal panels and covers prior to performing survey.
- D. Perform with equipment energized during periods of maximum possible loading per NFPA 70B, Section 20.17.
- E. Use thermographic equipment capable of:
  - 1. Detecting emitted radiation.
  - 2. Converting detected radiation to visual signal.
  - 3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.
- F. Temperature Gradients:
  - 1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
  - 2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.
  - 3. 16 degrees C and above indicates deficiency that is to be corrected immediately.
- G. Provide written report of:
  - 1. Areas surveyed and the resultant temperature gradients.
  - 2. Locations of areas having temperature gradients of 3 degrees C or greater.
  - 3. Cause of heat rise and actions taken to correct cause of heat rise.
  - 4. Detected phase unbalance.

# **END OF SECTION**

# SECTION 26 20 00 LOW-VOLTAGE AC INDUCTION MOTORS

# PART 1 GENERAL

## 1.01 RELATED SECTIONS

A. This section applies to low-voltage AC induction motors, whether or not referenced by a motor-driven equipment specification. If equipment specification section deviates from this section in requirements such as, application, horsepower, enclosure type, mounting, shaft type, or synchronous speed, then those listed requirements shall take precedence over this section.

## 1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Bearing Manufacturers Association (ABMA):
    - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
    - b. 11, Load Ratings and Fatigue Life for Roller Bearings.
  - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
    - b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
    - c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
  - 3. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - b. C50.41, Polyphase Induction Motors for Power Generating Stations.
    - c. MG 1, Motors and Generators.
  - 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 5. UL:
    - a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
    - b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
    - c. 2111, Standard for Safety for Overheating Protection for Motors.

### 1.03 DEFINITIONS

- A. CISD-TEFC: Chemical industry, severe-duty enclosure.
- B. DIP: Dust-ignition-proof enclosure.
- C. EXP: Explosion-proof enclosure.
- D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.
- E. Inverter Ready Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Part 31.4.4.2.
- F. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.
- G. ODP: Open drip-proof enclosure.
- H. TEFC: Totally enclosed, fan-cooled enclosure.
- I. TENV: Totally enclosed, nonventilated enclosure.
- J. VPI: Vacuum pressure impregnated.
- K. WPI: Open weather protected enclosure, Type I.
- L. WPII: Open weather protected enclosure, Type II.

## 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Descriptive information.
  - 2. Nameplate data in accordance with NEMA MG 1.
  - 3. Additional Rating Information:
    - a. Service factor.
    - b. Locked rotor current.
    - c. No load current.
    - d. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
    - e. Guaranteed minimum full load efficiency and power factor.
  - 4. Enclosure type and mounting (such as, horizontal, vertical).
  - 5. Dimensions and total weight.

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- 6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
- 7. Bearing type.
- 8. Bearing lubrication.
- 9. Bearing life.
- 10. Space heater voltage and watts.
- 11. Description, ratings, and wiring diagram of motor thermal protection.
- 12. Motor sound power level in accordance with NEMA MG 1.
- 13. Maximum brake horsepower required by the equipment driven by the motor.
- 14. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 2. Factory test reports
  - 3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
  - 4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services

# PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
  - 1. Baldor.
  - 2. U.S. Electrical Motors.
  - 3. TECO-Westinghouse Motor Co.
  - 4. Toshiba International Corp., Industrial Division.
  - 5. WEG Electric Motors Corp.

### 2.02 GENERAL

- A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
- B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.
- C. Meet requirements of NEMA MG 1.

- D. For motors used in hazardous (classified) locations, Class I, Division 1, Groups B, C, and D, and Class II, Division 1, Groups E, F, and G provide motors that conform to UL 674 and have an applied UL listing mark.
- E. Provide motors specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
- F. Lifting lugs on motors weighing 100 pounds or more.
- G. Operating Conditions:
  - 1. Maximum ambient temperature not greater than 50 degrees C.
  - 2. Provide motors suitable for operating conditions without reduction in nameplate rated horsepower or exceeding rated temperature rise.
  - 3. Overspeed in either direction in accordance with NEMA MG 1.

#### 2.03 HORSEPOWER RATING

- A. As designated in motor-driven equipment specification.
- B. Constant Speed Applications: Brake horsepower of driven equipment at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.
- C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor, Inverter Ready Motor): Driven equipment brake horsepower any at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

#### 2.04 SERVICE FACTOR

- A. Inverter-Duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.
- B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

#### 2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

Voltage Rating			
Size	Voltage	Phase	
1/2 hp and smaller	115	1	
3/4 hp through 400 hp	460	3	
450 hp and larger	4,000	3	

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specification:

- C. Suitable for full voltage starting.
- D. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.
- E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

#### 2.06 EFFICIENCY AND POWER FACTOR

- A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
  - 1. Efficiency:
    - a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
    - b. Guaranteed minimum at full load in accordance with NEMA MG 1 or as indicated in motor-driven equipment specification.
  - 2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

#### 2.07 LOCKED ROTOR RATINGS

- A. Locked rotor kVA Code G or lower, if motor horsepower not covered by NEMA MG 1 tables.
- B. Safe Stall Time: 12 seconds or greater.

#### 2.08 INSULATION SYSTEMS

- A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.
- B. Motors Rated Over 600 Volts: VPI windings in accordance with NEMA MG 1.

P PW\JACOBS AMERICAS\D3418006 FEBRUARY 28, 2023 ©COPYRIGHT 2023 JACOBS C. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class F with Class B rise at nameplate horsepower and designated operating conditions

#### 2.09 ENCLOSURES

- A. Conform to NEMA MG 1.
- B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

#### 2.10 TERMINAL (CONDUIT) BOXES

- A. Oversize main terminal boxes for motors.
- B. Aux accessory box.
- C. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.
- D. Except ODP, furnish gaskets between box halves and between box and motor frame.
- E. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

<b>Terminal Box Usable Values</b>			
Voltage	Horsepower	Percentage	
Below 600	15 through 125	500	
Below 600	150 through 300	275	
Below 600	350 through 600	225	
Above 600	All sizes	200	

- F. Terminal for connection of equipment grounding wire in each terminal box.
- G. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on the Drawings.

### 2.11 BEARINGS AND LUBRICATION

- A. Horizontal Motors:
  - 1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

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- 2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
- 3. For Direct Drive Equipment: Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
- 4. For Belt Driven Equipment: Minimum 30,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
- B. Vertical Motors:
  - 1. Thrust Bearings:
    - a. Antifriction bearing.
    - b. Manufacturer's standard lubrication 75 hp and smaller.
    - c. Oil lubricated 100 hp and larger.
    - d. Minimum 50,000 hours L-10 bearing life.
  - 2. Guide Bearings:
    - a. Manufacturer's standard bearing type.
    - b. Manufacturer's standard lubrication 200 hp and smaller.
    - c. Oil lubricated 250 hp and larger.
    - d. Minimum 100,000 hours L-10 bearing life.
- C. Regreasable Antifriction Bearings:
  - 1. Readily accessible, grease injection fittings.
  - 2. Readily accessible, removable grease relief plugs.
- D. Oil Lubrication Systems:
  - 1. Oil reservoirs with sight level gauge.
  - 2. Oil fill and drain openings with opening plugs.
  - 3. Provisions for necessary oil circulation and cooling.
- E. Inverter Duty Rated Motors Larger than 50 hp, Bearing Isolation: Provide electrically isolated bearings to prevent stray current damage.
- 2.12 NOISE
  - A. Measured in accordance with NEMA MG 1.
  - B. Maximum Sound Level for Motors Controlled by Adjustable Frequency Drive Systems: 3 dBA higher than NEMA MG 1.
- 2.13 BALANCE AND VIBRATION CONTROL
  - A. In accordance with NEMA MG 1, Part 7.

#### SWF BAF IMPROVEMENTS

#### 2.14 EQUIPMENT FINISH

- A. Protect Motor for Service Conditions:
  - 1. ODP Enclosures: Indoor industrial atmospheres.
  - 2. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.
- B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

#### 2.15 SPECIAL FEATURES AND ACCESSORIES

- A. Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.
- B. Winding Thermal Protection:
  - 1. Thermostats:
    - a. Motors for constant speed application 75 hp through 150hp. Motors for adjustable speed application 200 hp
    - b. Bi-metal disk or rod type thermostats embedded in stator windings.
    - c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
    - d. Leads extending to separate terminal box for motors 100 hp and larger.
  - 2. Thermistors:
    - a. Motors for adjustable speed application 200hp
    - b. Thermistor embedded in each stator phase winding before winding dip and bake process.
    - c. In intimate contact with winding conductors.
    - d. Control module rated for 120V ac power supply.
    - e. Control module automatically reset contact for external use rated 120V ac, 5 amps minimum, opening on abnormally high winding temperature. Provide manual reset at motor controller.
- C. Space Heaters:
  - 1. Provide winding space heaters with leads wired out to motor terminal box separate condulet or terminal box.
  - 2. Unless shown otherwise, heater shall be suitable for 120V ac supply, with wattage suitable for motor frame size.

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## D. Nameplates:

- 1. Raised or stamped letters on stainless steel or aluminum.
- 2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
- 3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.
- E. Anchor Bolts: Provide meeting manufacturer's recommendations and of sufficient size and number for specified seismic condition.

### 2.16 SPECIAL MOTORS

- A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.
- B. Inverter Duty Motor:
  - 1. Motor Supplied Power by Adjustable Voltage and Adjustable Frequency Drives: Inverter duty rated in accordance with NEMA Parts 30 and 31.
  - 2. Provide winding insulation rated 1,600 peak volts, minimum.
  - 3. Meet or exceed NEMA MG 1 corona inception voltage rating.
  - 4. Provide one insulated bearing.
  - 5. Suitable for operation over entire speed range indicated.
  - 6. Provide forced ventilation where speed ratio is greater than published range for motor provided.
  - 7. Shaft Grounding Device, Motors Larger than 150 hp: Furnish with shaft grounding brush or conductive micro fiber shaft grounding ring solidly bonded to grounded motor frame in accordance with manufacturer's recommendations.
    - a. Manufacturers:
      - 1) Grounding Brush: Sohre Turbomachinery, Inc.
      - 2) Grounding Ring: EST-Aegis.

### 2.17 FACTORY TESTING

- A. Tests:
  - 1. In accordance with IEEE 112 for polyphase motors.
  - 2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.

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- 3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
  - a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
  - b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
- B. Test Report Forms:
  - 1. Routine Tests: IEEE 112, Form A-1.
  - 2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1,

#### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. In accordance with manufacturer's instructions and recommendations.
- B. Align motor carefully and properly with driven equipment.
- C. Secure equipment to mounting surface with anchor bolts.

#### 3.02 MANUFACTURER'S SERVICES

A. Manufacturer's Certificate of Proper Installation.

#### 3.03 FIELD QUALITY CONTROL

A. Refer to Section 26 08 00, Commissioning of Electrical Systems.

### **END OF SECTION**

### SECTION 26 22 00 LOW-VOLTAGE TRANSFORMERS

## PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. Code of Federal Regulations (CFR): 10 CFR Part 431, DOE 2016 efficiency.
  - 2. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
  - 3. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
  - 4. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - b. ST 20, Dry-Type Transformers for General Applications.
  - 5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 6. UL:
    - a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
    - b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
    - c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

### 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Descriptive information.
  - 2. Dimensions and weight.
  - 3. Transformer nameplate data, including efficiency.
  - 4. Schematic and connection diagrams.
  - 5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

- 2. Test Report: Sound test certification for dry type power transformers (0 volt to 600 volt, primary).
- 3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

## PART 2 PRODUCTS

#### 2.01 GENERAL

- A. UL 1561, NEMA ST 20, unless otherwise indicated.
- B. Dry-type, self-cooled, two-winding, with copper windings.
- C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- D. Efficiency: Meet or exceed DOE 2016 efficiency requirements.
- E. Maximum Sound Level per NEMA ST 20:
  - 1. 40 decibels for 0 kVA to 9 kVA.
  - 2. 45 decibels for 10 kVA to 50 kVA.
  - 3. 50 decibels for 51 kVA to 150 kVA.
  - 4. 55 decibels for 151 kVA to 300 kVA.
  - 5. 60 decibels for 301 kVA to 500 kVA.
- F. Overload capability: Short-term overload per IEEE C57.96.
- G. Wall Bracket: For single-phase units, 15 kVA to 37-1/2 kVA, and for three-phase units, 15 kVA to 30 kVA.
- H. Vibration Isolators:
  - 1. Rated for transformer's weight.
  - 2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
  - 3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
  - 4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.
- I. Manufacturers:
  - 1. Square D.
  - 2. Eaton.
  - 3. "Or-equal" approved.

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### 2.02 GENERAL PURPOSE TRANSFORMER

- A. Insulation Class and Temperature Rise: Manufacturer's standard.
- B. Core and Coil:
  - 1. Encapsulated for single-phase units 1/2 kVA to 25 kVA and for three-phase units 3 kVA to 15 kVA.
  - 2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.
- C. Enclosure:
  - 1. Single-Phase, 3 kVA to 25 kVA: NEMA 250, Type 3R, nonventilated.
  - 2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
  - 3. Three-Phase, 3 kVA to 15 kVA: NEMA 250, Type 3R, nonventilated.
  - 4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
  - 5. Outdoor Locations: NEMA 250, Type 3R.
  - 6. Corrosive Locations: NEMA 250, Type 3R stainless steel.
- D. Voltage Taps:
  - 1. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

#### 2.03 K-RATED TRANSFORMER

- A. Insulation Class and Temperature Rise: Manufacturer's standard. 115 degrees C temperature rise.
- B. Core and Coil: Sized and configured to reduce overheating caused by harmonic components.
- C. Enclosure: NEMA 250, Type 4X aluminum with weathershield.
- D. Voltage Taps: Six 2.5 percent, full capacity; two above and four below normal voltage rating.
- E. K Factor: K-13.
- F. Neutral Bus and Terminal: 200 percent of rated current.
- G. Electrostatic shield.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Install in accordance with NECA and manufacturer's instructions.
- B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.
- C. Provide moisture-proof, flexible conduit for electrical connections.
- D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.
- E. Provide wall brackets for single-phase units, 15 kVA to 167-1/2 kVA, and three-phase units, 15 kVA to 30 kVA.
- **F.** Isolation Transformer: Ground isolation shields to unit enclosure with conductor of same material, and same size minimum, as shield ground lead provided with unit.

## **END OF SECTION**

## SECTION 26 24 16 PANELBOARDS

### PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
  - 2. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - b. 289, Application Guide for Ground Fault Circuit Interrupters.
    - c. KS 1, Enclosed Switches.
    - d. PB 1, Panelboards.
    - e. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
  - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 4. UL:
    - a. 67, Standard for Panelboards.
    - b. 98, Standard for Enclosed and Dead-Front Switches.
    - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
    - d. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
    - e. 508, Standard for Industrial Control Equipment.
    - f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
    - g. 943, Ground-Fault Circuit-Interrupters.
    - h. 1699, Standard for Arc-Fault Circuit-Interrupters.

### 1.02 RELATED SECTIONS

- A. Section 26 05 02, Basic Electrical Requirements.
- B. Section 26 05 04, Basic Electrical Materials and Methods.
- C. Section 26 05 70, Electrical System Analysis.
- D. Section 26 43 00, Surge Protective Devices.

#### SWF BAF IMPROVEMENTS

#### 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
  - 2. Manufacturer's Shop Drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
  - 3. Tabulation of features for each panelboard to include the following:
    - a. Protective devices with factory settings.
    - b. Provisions for future protective devices.
    - c. Space for future protective devices.
    - d. Voltage, frequency, and phase ratings.
    - e. Enclosure type.
    - f. Bus and terminal bar configurations and current ratings.
    - g. Provisions for circuit terminations with wire range.
    - h. Short circuit current rating of assembled panelboard at system voltage.
    - i. Features, characteristics, ratings, and factory settings of auxiliary components.
    - j. Wiring and schematic diagrams detailing control wiring, and differentiating between manufacturer-installed and field-installed wiring.
    - k. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 2. Manufacturer's recommended installation instructions.
  - 3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

### 1.04 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
  - 1. Power Distribution Panelboard: Square D I-Line Panelboard.
  - 2. Branch Panelboard: Square D.

### 2.02 RATINGS

- A. Panelboard rated 250-V or less shall have a short circuit rating as shown on the Drawings or panelboard schedule, but not less that indicated in the electrical analysis. Short circuit rating must be equal or greater than the values in the Electrical Analysis short circuit study.
- B. Panelboard rated 600-V or less shall have a short circuit rating as shown on the Drawings or single line diagram, but not less that indicated in the electrical analysis. Short circuit rating must be equal or greater than the values in the Electrical Analysis short circuit study.

### 2.03 GENERAL

- A. Provide low voltage Branch Panelboards for application at 250-V or less in accordance with this section.
- B. Provide low voltage Power Distribution Panelboards for application at 600V or 480-V in accordance with this section.
- C. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.
- D. Wire Terminations:
  - 1. Provide panelboard assemblies, including protective devices, suitable for use with 75 degrees C or greater wire insulation systems at NFPA 70, 75 degrees C conductor ampacity, and in accordance with UL 486E.
  - 2. Lugs for termination of conductors shall comply with Section 26 05 05, Conductors.
  - 3. Lugs for termination of copper feeder phase and neutral conductors shall be replaceable, bolted mechanical or crimp compression type.

- E. Load Current Ratings:
  - 1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
  - 2. Where indicated "continuous" or "100 percent", selected components and protective devices shall be rated for continuous load current at value shown.
- F. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the indicated SCCR.
- G. Series-Connected Short Circuit Current Ratings: Panelboards shall be fully rated; application of series-connected device ratings is unacceptable

#### 2.04 OVERCURRENT PROTECTIVE DEVICES

- A. Overcurrent Device Mounting and Arrangement: Design panelboards to accommodate device installation and replacement without disturbing adjacent devices and without removing main bus.
- B. Overcurrent Protective Devices: In accordance with NEMA KS 1, UL 98, and UL 489. Protective devices shall be adapted to panelboard installation.
- C. Provisions for Future Overcurrent Device:
  - 1. Provide space, mountings and bus connections such that like device may be installed without additional hardware.
  - 2. Panel openings shall be closed with individual removable cover for each provision for future device.
  - 3. Unless otherwise indicated, "spaces" in panelboards shall be fully equipped provision for future like devices.
  - 4. Provisions for future devices shall be suitable devices rated no less than 60 amperes.
- D. Branch Protective Devices:
  - 1. Provide Wire Lug Load Connections: Mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
  - 2. Provide a nameplate for each circuit, blanks for spares.

### 2.05 PANELBOARD INTERIOR – DISTRIBUTION

- A. Shall be rated 480-V maximum. Continuous main current ratings as indicated on associated Drawings not to exceed 1200 amperes maximum main lugs or main circuit breaker. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
- B. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated Drawing not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 65,000 RMS symmetrical amperes.
- C. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
- D. The bussing shall be fully rated with sequentially phased branch distribution. Bussing rated 800 amperes and above shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two U-shaped steel channels, permanently secured to a galvanized steel-mounting pan by fasteners.
- E. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
- F. A solidly bonded copper equipment ground bar shall be provided.
- G. Circuit Breakers:
  - 1. Group mounted circuit breakers through 1200A.
  - 2. Circuit breaker(s) shall be group mounted with plug-on electrical connection, bolted to common pan or rail assembly.
  - 3. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
  - 4. Line-side circuit breaker connections are to be jaw type.
  - 5. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate breaker connectors and mounting hardware.

- 6. Electronic Solid State Trip Units: Where indicated, equip breakers with solid state trip units.
  - a. Long (Time) Short (Time) Instantaneous (LSI): Electronic trip unit with fixed long-time trip, adjustable short-time trip and delay, and adjustable instantaneous trip settings.
  - b. Long (Time) Short (Time) Instantaneous Ground (Fault) (LSIG): Electronic trip unit as above and also with adjustable ground fault trip and delay settings.

#### 2.06 PANELBOARD INTERIOR-BRANCH

- A. Shall be rated 208-V/120-V maximum. Continuous main current ratings as indicated on associated schedules not to exceed 400 amperes maximum main lugs or main circuit breaker. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
- B. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated schedules not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 22,000 RMS symmetrical amperes.
- C. Circuit Breakers:
  - 1. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle. Circuit breakers shall comply with Section 26 05 04, Basic Electrical Materials and Methods.
  - 2. Bus Connection: Bolt-on circuit breakers in all panelboards.
  - 3. Trip Mechanism:
    - a. Individual permanent thermal and magnetic trip elements in each pole.
    - b. Solid State Trip Units for frames greater than 100 amps.
    - c. Two and three pole, common trip.
    - d. Automatically opens all poles when overcurrent occurs on one pole.
    - e. Test button on cover.
    - f. Calibrated for 40 degrees C ambient, unless shown otherwise.
- D. Unacceptable Substitution:
  - 1. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
  - 2. Do not use tandem or dual circuit breakers in normal single-pole spaces.

- E. Specialty Breakers: Where indicated, provide breakers with the following features:
  - 1. Ground Fault Circuit Interrupter (GFCI): Rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel). Ground fault sensor shall be rated same as circuit breaker. Breaker shall include push-to-test and reset buttons.
- F. Electronic Solid State Trip Units: Where indicated, equip breakers with solid state trip units.
  - 1. Long (Time) Short (Time) Instantaneous (LSI): Electronic trip unit with fixed long-time trip, adjustable short-time trip and delay, and adjustable instantaneous trip settings.
  - 2. Long (Time) Short (Time) Instantaneous Ground (Fault) (LSIG): Electronic trip unit as above and also with adjustable ground fault trip and delay settings.
- G. Enclosures:
  - 1. General:
    - a. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
    - b. Type 3R, and Type 4X,
    - c. Provide surface-mount panelboard from trim with same dimensions as box front.
  - 2. Finish: Rust inhibitor prime followed by manufacturer's standard gray baked enamel or lacquer.
  - 3. NEMA 250 Type 4x Branch Panelboard Enclosure:
    - a. Secure front trim to box with concealed trim clamps.
    - b. Overlap flush panelboards front trims with box nominal 3/4 inch on all sides.
    - c. Provide door in panelboard front trim, with concealed hinges, to access protective device operating handles.
    - d. Provide multi-point latching for doors over 30 inches in height.
    - e. Door Lock: Secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
    - f. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.
    - g. Hinged Front Cover (Door In Door): Entire front trim hinged to surface box with standard door within hinged trim cover.
  - 4. Multi-Section Panelboards: Where more than one section is required, provide multiple panelboard sections with separate fronts.
    - a. Sections shall be suitable for individual mounting to be field interconnected to form a single electrical unit.
    - b. Recessed-mount sections of the same panel shall all have the same size tubs and flush covers.

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- c. Surface-mount multi-section panelboards may be comprised of sections of unequal heights.
- d. Provide feed-through and main lugs in individual sections as required for field assembly of a complete multi-section panelboard. Unless otherwise indicated, provide feed-through lugs on each section but last.
- e. Provide neutral and ground terminal bars in each section.

### H. BUSSING AND TERMINAL BARS

- 1. Bus:
  - a. Material: Tin plated copper full sized throughout length.
  - b. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
- I. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.
  - 1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
  - 2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.
- J. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.
  - 1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
  - 2. Provide individual termination points for all other neutral conductors.
- K. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

#### 2.07 SPECIAL FEATURES

- A. General: Where indicated on the Drawings or schedules, provide special features as specified.
- B. Surge Arresters:
  - 1. Comply with Section 26 43 00, Surge Protection Devices.
  - 2. Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer's recommendation.
  - 3. Provide factory mounting within panelboard utilizing UL-recognized mounting device.

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# PART 3 EXECUTION

### 3.01 GENERAL

- A. Install in accordance with NECA 407, NEMA PB 1.1, and manufacturers' written installation instructions.
- B. Install securely, plumb, in-line and square with walls.
- C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.
- D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.
- E. Install filler plates in unused spaces.
- F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle and wrap with nylon wire ties.
- G. Mount flush panels uniformly flush with wall finish.
- H. Provide typewritten circuit directory for each panelboard.
- I. In addition to conduit or nipples otherwise required for feeder and branch circuit wiring between multi-section panelboard sections, provide nipples for branch circuits two trade sizes larger than required for installed branch circuit wires or an empty 2-inch nipple, or a 1-1/4-inch trade size conduit if tubs are more than 24 inches apart.
- J. Provide engraved identification for each protective device.

# **END OF SECTION**

### SECTION 26 24 19 LOW-VOLTAGE MOTOR CONTROL

## PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which shall be followed for this section:
  - 1. Institute of Electrical and Electronics Engineers (IEEE):
    - a. C2, National Electrical Safety Code (NESC).
    - b. C37.20.7, Guide for Testing Metal Enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults.
  - 2. National Electrical Contractors Association (NECA): 402, Standard for Installing and Maintaining Motor Control Centers.
  - 3. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
    - b. ICS 1, Industrial Control and Systems: General Requirements.
    - c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.
    - d. ICS 2.3, Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600V.
    - e. ICS 18, Motor Control Centers.
    - f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
  - 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 5. UL:
    - a. 98, Enclosed and Dead-Front Switches.
    - b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
    - c. 845, Motor Control Centers.

### 1.02 DEFINITIONS

- A. LCD: Liquid Crystal Display.
- B. N.C.: Normally Closed.
- C. N.O.: Normally Open.
- D. SPD: Surge Protection Device.

#### SWF BAF IMPROVEMENTS

#### 1.03 RELATED SPECIFICATIONS

- A. Section 26 05 01, Basic Electrical Requirements.
- B. Section 26 05 04, Basic Electrical Materials and Methods.
- C. Section 26 05 70, Electrical System Analysis.

#### 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Descriptive information.
  - 2. Itemized Bill of Material.
  - 3. Dimensional drawings.
  - 4. Front Panel Elevations.
  - 5. Conduit entrance locations.
  - 6. Bus data.
  - 7. Protective Devices: Copies of time-current characteristics.
  - 8. Communication protocol setup and parameter setting information for plant control system communication programming.
  - 9. Operational description.
  - 10. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
  - 11. Anchoring instructions and details.
  - 12. Anchoring instructions and details.
  - 13. Typed Tabulation:
    - a. Motor name; tag (equipment) numbers as shown on the Drawings.
    - b. Motor horsepower.
    - c. Nameplate full load current.
    - d. Measured load current and voltage.
    - e. Overload model number and setting.
    - f. Protective device trip settings.
    - g. Manufacturer's solid state starter switch or dip switch or program settings.
    - h. Attach above typed, tabulated data to a copy of starter manufacturer's overload relay or setting selection tables for starters provided.
  - 14. Control diagrams.
  - 15. One-line diagrams.
  - 16. Schematic (elementary) diagrams.
  - 17. Outline diagrams.
  - 18. Interconnection diagrams.

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- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 2. Manufacturer's installation instructions.
  - 3. Factory test reports, certified.
  - 4. Operation and Maintenance Data as specified in Section 01 78 23.

### 1.05 QUALITY ASSURANCE

A. Provide products manufactured within scope of UL that conform to UL Standards and have applied UL Listing Mark.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping Splits: Established by Contractor to facilitate ingress of equipment to final installation location within building.

## PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Provide materials, equipment, and accessories specified in this section manufactured by:
  - 1. Schneider Electric.

### 2.02 GENERAL

- A. Like Items of Equipment: same manufacturer as low voltage switchboard and panelboards for standardization.
- B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.
- C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.
- D. Control Transformer:
  - 1. Two winding, 120-volt secondary, primary voltage to suit.
  - 2. Two current-limiting fuses for primary circuit.
  - 3. One fuse in secondary circuit with blown fuse indicator.
  - 4. Mount within starter unit.
- E. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

- F. Lifting lugs on equipment and devices weighing over 100 pounds.
- G. Anchor Bolts: Seismically by a licensed structural engineer registered in the State where equipment is to reside and as specified in Section 05 50 00, Metal Fabrications.
- H. Operating Conditions:
  - 1. Ambient Temperature: Maximum 40 degrees C.
  - 2. Altitude: Above sea level.
  - 3. Equipment to be fully rated.
- I. Enclosures: In accordance with NEMA 250.
- J. Equipment Finish:
  - 1. Electrocoating process applied over rust-inhibiting phosphated base coating.
  - 2. Exterior Color: Manufacturer's standard.

#### 2.03 SEPARATELY MOUNTED MOTOR CONTROL

- A. Combination Reduced Voltage, Solid State Starter:
  - 1. Rating: Horsepower rated at 600 volts, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
  - 2. Three-phase, nonreversing with bypass run contactor.
  - 3. Control: HAND/OFF/AUTO selector switch. STOP/START pushbutton.
  - 4. Disconnect Type: Motor circuit protector.
  - 5. Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
  - 6. Kick start, with adjustable torque and time settings.
  - 7. Ramp start, selectable current or torque, and adjustable time.
  - 8. Smooth stop ramp, adjustable time.
  - 9. Phase loss unbalance and phase reversal protection.
  - 10. LED display or LCD of fault, N.O. contact to communicate fault conditions.
  - 11. Enclosure: NEMA 250, Type 4X
  - 12. Pilot Lights: Red–ON and Green–OFF.
  - 13. Padlockable operating handle, capable of up to three locks.
- B. Solid State Motor Overload Protection:
  - 1. Inverse-time-limit characteristic.
  - 2. Phase loss, phase unbalanced and Class II ground fault protection.

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- 3. Current operated electronic circuitry with adjustable trip.
- 4. Class 10/20/30 relay trip, switch selectable.
- 5. N.O. auxiliary contact for remote monitoring.
- 6. Manual reset.
- 7. Provide in each ungrounded phase.
- 8. Mount within starter unit.
- C. SPD: As specified in Section 26 43 00, Surge Protection Devices.
- D. COMMUNICATION: MODBUS/ ETHERNET TCP
- E. Pushbuttons, Indicating Lights, Selector Switches, Elapsed Time Meters, Control Relays, Time-Delay Relays, and Reset Timers: As specified in Section 26 05 04, Basic Electrical Materials and Methods.
- F. Nameplates:
  - 1. Laminated plastic; white, engraved to black core.
  - 2. Provide for each motor control center and each unit.
  - 3. Engrave with inscription shown on single-line diagram.
  - 4. Provide blank nameplates on spaces for future units.
  - 5. Attach with stainless steel panhead screws on face of control center.
- G. Space Heaters: Thermostatically controlled. Locate in bottom of each vertical section for operation from 120-volt power source derived external to Starter.

#### 2.04 SOURCE QUALITY CONTROL

- A. Factory Testing:
  - 1. Applicable Standards: NEMA ICS 18, UL 845, and NEC Article 430, Part VIII.
  - 2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.
  - 3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.
  - 4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.
  - 5. Control Circuits and Devices:
    - a. Energize circuit at rated voltage.
    - b. Operate control devices.
    - c. Perform continuity check.

- 6. Instruments, Meters, Protective Relays, and Equipment:
  - a. Verify devices functioned by energizing potential to rated values with connection to devices made at outgoing terminal blocks.
  - b. Verify protective relays operated for functional checks and trips manually initiated to verify functioning of operation for indicator and associated circuits.
- 7. Perform dielectric tests on primary circuits and equipment, except potential transformers.
  - a. Tests: Phase-to-phase and phase-to-around with 60-cycle test voltages applied for 1 second at 2,640 volts.
- 8. Verify equipment passed tests and inspection.
- 9. Provide standard factory inspection and test checklists, and final certified and signed test report.

## PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. General:
  - 1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer's written instructions and recommendations.
  - 2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
  - 3. Install equipment plumb and in longitudinal alignment with pad or wall.
  - 4. Coordinate terminal connections with installation of secondary feeders.
  - 5. Grout mounting channels into floor or mounting pads.
  - 6. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.
  - 7. Motor Data: Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
    - a. Motor served by tag number and equipment name.
    - b. Nameplate horsepower.
    - c. Motor code letter.
    - d. Full load amperes.
    - e. Service factor.
    - f. Installed overload relay catalog number.
- B. Circuit Breakers:
  - 1. Field adjust trip settings of feeder circuit breakers with solid state trip units and motor starter magnetic-trip-only circuit breakers.
  - 2. Adjust to approximately 11 times motor rated current.
  - 3. Determine motor rated current from motor nameplate following installation.

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C. Solid State Overload Relay: Select and install overload relay and apply settings based upon actual full-load current of motor and the protection coordination study provided under Section 26 05 70, Electrical Analysis.

### 3.02 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at Job Site or classroom as designated by Owner for minimum person-days listed below, travel time excluded:
  - 1. 1 person-day for installation assistance, and inspection of installation.
  - 2. 1 person-day for functional and performance testing.
  - 3. 1 person-day for plant startup.
  - 4. 1 person-day for training of Owner's personnel.

#### **END OF SECTION**

### SECTION 26 29 23 LOW VOLTAGE ADJUSTABLE FREQUENCY DRIVE SYSTEMS

## PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. Electronic Industries Alliance (EIA), Telecommunications Industry Association (TIA): 359-1, Special Colors.
  - 2. Institute of Electrical and Electronics Engineers (IEEE):
    - a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
    - b. 519, Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
    - c. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
  - 3. National Electrical Manufacturer's Association (NEMA):
    - a. CP 1, Shunt Capacitors.
    - b. MG 1, Motors and Generators.
    - c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
    - d. WC-57, Control Cables.
  - 4. National Fire Protection Association (NFPA): Electrical Standard for Industrial Machinery.

### 1.02 DEFINITIONS

- A. Terms that may be used in this section:
  - 1. AFD: Adjustable frequency drive.
  - 2. CMOS: Complementary metal oxide semiconductor.
  - 3. GTO: Gate Turn-Off Thyristor.
  - 4. MPR: Motor protection relay.
  - 5. MTBF: Mean time between failure
  - 6. PWM: Pulse width modulation.
  - 7. ROM: Read only memory.
  - 8. RTD: Resistance temperature detector.
  - 9. Rated Load: Load specified for the equipment.
  - 10. Rated Speed: Nominal rated (100 percent) speed specified for the equipment.
  - 11. TDD: Total demand distortion.
  - 12. THD: Total harmonic distortion.
  - 13. TTL: Transistor logic.

#### SWF BAF IMPROVEMENTS

#### 1.03 SYSTEM DESCRIPTION

#### A. Performance Requirements:

- 1. This Specification covers supply, installation, testing and commissioning of Adjustable Frequency Drives. As a minimum, all drives larger than 75 hp shall be 12-pulse, and Manufacturer may choose to provide higher pulse converters or harmonic filters as required to meet the current and voltage distortion limits.
- 2. Manufacturer to provide external 12 -pulse transformer external to the variable frequency drives.
- 3. Rated Continuous Operation Capacity: Not less than 1.0 times full load current rating of driven motor, as indicated on the motor nameplates, and suitable for continuous operation at any continuous overload which may be imposed on motor by driven pump operating over specified speed range.
- 4. Basis for Harmonic Computations: Compute individual and total current and voltage distortion. At the incoming line terminals Existing Switchboard reference Drawing 80-E-601. Furnish harmonic filters, line reactors, isolation transformers, or higher pulse converter arrangements required to meet current/voltage distortion limits.
- 5. Normal Source Current Harmonic Distortion:
  - a. Compute normal source individual and total current harmonic distortion. At the incoming Line Terminals of the Existing Switchboard, in accordance with IEEE Standard 519. Although the short circuit ratios of the motor control centers may be higher than 20, the harmonic distortion limits specified below are deliberately specified for ratio of less than 20, which will be the case in future. Individual current harmonic distortion and the total demand distortion expressed as percent of maximum demand load current  $I_L$  shall not exceed values specified in Table 1 below:

Table 1		
Individual Harmonic Order (Odd Harmonics)	Harmonic Current Distortion Percent of Max. Demand Load Current I <sub>L</sub>	
h <11	1	
11 < = h < 17	0.5	
17 < = h < 23	0.375 (2.598 percent for h=17,19)	
23 < = h < 35	0.15	
35 < = h	0.075 (0.520 percent for h=35,37)	
Total Demand Distortion (TDD)	5	

- b. Limits specified in Table 1 are for drives utilizing 12-pulse rectifiers with a 12 pulse transformer.
- c. For harmonic computations, assume all drives running at full load.
- 6. Normal Source Voltage Harmonic Distortion: The individual voltage harmonic distortion computed at incoming line terminals of the Existing Switchboard shall be less than 3 percent and the total voltage harmonic distortion shall not exceed 5 percent.
- B. Design Requirements:
  - 1. Design and provide drive system consisting of adjustable frequency controller, drive motor, certain auxiliary items, and components necessary for complete operating system.
  - 2. Furnish VFDs rated on basis of actual motor full load nameplate current rating. (VFDs rating = 1.15\* full load motor nameplate current.)
  - 3. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using the pulse-width-modulation (PWM) technique to produce the adjustable frequency output.
  - 4. System rated for continuous industrial duty and suitable for use with Standard NEMA MG 1, Design B motors.
  - 5. Incoming Line Circuit Breaker: Provide positive means of disconnecting incoming power, and overcurrent protection for the drive system.
  - 6. 12 pulse transformer (external): Design to minimize harmonic distortion on the incoming power feeder.
  - 7. Output Reactor: Design to minimize voltage spikes at motor where long motor leads are indicated.
  - 8. The equipment furnished, including filters, transformed reactors, and contractors, must fit within the enclosures dimensions on the Drawings.
  - 9. Furnish and install a flanged lockable disconnect on the VFD control panel.

# 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.
  - 2. Individual and total harmonic content (voltage and current) reflected in system normal source supply at driven equipment actual load at 70 and 100 percent of rated speed at the incoming line terminals of the distribution panel DP-1. Show that the computed valves of individual

and total current and voltage harmonic distortion are below the specified limits.

- 3. VFD output pulse maximum peak voltage, pulse rise time and pulse rate of rise, including any justification for proposed deviation from specified values. Include motor manufacturer's certification that motor insulation will withstand long-term overvoltages caused at motor terminals due to specified output pulse data or any proposed deviation from this data.
- 4. Data on the shelf life of "dc link" capacitor.
- 5. Complete system rating, including all nameplate data, continuous operation load capability throughout speed range of 0 to 120 percent of rated speed.
- 6. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list any controller special features being supplied.
- 7. Controller, input line reactor, and output reactor (if applicable) dimensional drawings; information on size and location of space for incoming and outgoing conduit.
- 8. Maximum heat dissipation from enclosure.
- 9. Layout of controller face showing pushbuttons, switches, instruments, indicating lights, etc.
- 10. Complete system operating description.
- 11. Complete system schematic (elementary) wiring diagrams.
- 12. Complete system interconnection diagrams between controller, drive motor, and all related components or controls external to system, including wire numbers and terminal board point identification.
- 13. One-line diagram of system, including component ratings.
- 14. Description of diagnostic features being provided.
- 15. Descriptive literature for all control devices such as relays, selector switches, contactors, timers, etc.
- 16. Itemized bill-of-materials listing all system components.
- 17. Specific description of provisions, such as filters and harmonic suppression, being made to ensure proper system operation when system is supplied from standby engine generator specified in these Documents.
- B. Informational Submittals:
  - 1. Statement of Supplier qualifications.
  - 2. Factory functional test reports.
  - 3. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, showing rated load, rated speed efficiency meeting or exceeding specified values; motors not as specified will be rejected.
  - 4. Special shipping, storage and protection, and handling instructions.
  - 5. Manufacturer's printed installation instructions.

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- 6. Field test reports.
- 7. Manufacturer's Certification of Proper Installation.
- 8. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- 9. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
- 10. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

#### 1.05 QUALITY ASSURANCE

A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

#### 1.06 EXTRA MATERIALS

- A. Furnish for each drive unit:
  - 1. Complete set of components likely to fail in normal service.
  - 2. One Variable Frequency Drive Unit.

#### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Components and accessories specified in this section shall be products of:
  - 1. Yaskawa.
  - 2. Square-D.
  - 3. Allen-Bradley.

#### 2.02 SERVICE CONDITIONS

- A. Ambient Operating Temperature: 32 to 104 degrees F.
- B. Storage Temperature: Minus 40 to 158 degrees F.
- C. Humidity: 0 to 95 percent relative (noncondensing).
- D. Altitude: 0 to 3,300 feet.
- E. Frequency Stability: Plus or minus 0.1 percent of maximum frequency.
- F. Atmosphere: Corrosive.

### 2.03 COMPONENTS

- A. Drive Units:
  - 1. Incorporate a switching power supply operating from a dc bus, to produce a PWM output waveform simulating a sine wave and providing power loss ride through of 2 milliseconds at full load, full speed.
  - 2. Current-limiting semiconductor fuses for protection of internal power semiconductors.
  - 3. Employ a diode bridge rectifier providing a constant displacement power factor of 0.95 minimum at all operating speeds and loads.
  - 4. Use transistors for output section, providing a minimum 97 percent drive efficiency at full speed, full load.
  - Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50 volts dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.
  - 6. Operate with an open circuited output.
  - 7. Input Voltage: 480V ac plus or minus 10 percent.
  - 8. Output Voltage: 0 to 480 volts, three-phase, 0 to 66-Hz, minimum.
  - 9. Maximum peak voltage of PWM AFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and a maximum rate of rise of 500 volts per microsecond. Maximum frequency of PWM AFD output pulse (carrier) frequency of 3,000-Hz. Should magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish insulation systems on the motors suitable for the proposed values.
  - 10. Motor Audible Noise Level: When operating throughout speed range of PWM VFD, no more than 3 dBA above that designated in NEMA MG 1 for same motor operated at constant speed with a 60-Hz supply voltage.
  - 11. Short-Time Overload Capacity: 125 percent of rated load in rms current for 1 minute following full load, full speed operation.
  - 12. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source three-phase, bolted fault, short-circuit available of 65,000 amps rms symmetrical at 480 volts.
  - 13. Furnish drives with output current-limiting reactors mounted within equipment enclosure.
  - 14. Diagnostics: Comprehensive for drive adjustment and troubleshooting:
    - a. Memory battery backup; 100-hour minimum during a power loss.
    - b. Status messages will not stop drive from running but will prevent it from starting.
- c. Fault Condition Messages and History: First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults numerically:
  - 1) Overcurrent (time and instantaneous).
  - 2) Overvoltage.
  - 3) Undervoltage (dc and ac).
  - 4) Overtemperature (drive, motor windings, motor bearing, pump bearing).
  - 5) Serial communication fault.
  - 6) Short-circuit/ground fault (motor and drive).
  - 7) Motor stalled.
  - 8) Semiconductor fault.
  - 9) Microprocessor fault.
  - 10) Single-phase voltage condition.
- 15. Drive Protection:
  - a. Fast-acting semiconductor fuses.
  - b. Overcurrent, instantaneous overcurrent trip.
  - c. Dc undervoltage protection, 70 percent dropout.
  - d. Dc overvoltage protection, 130 percent pickup.
  - e. Overtemperature, drive, inverter, converter, and dc link components.
  - f. Overtemperature, motor, and pump.
  - g. Single-phase protection.
  - h. Reset overcurrent protection (manual or automatic reset).
  - i. Active current limit/torque limit protection.
  - j. Semiconductor fault protection.
  - k. Short-circuit/ground fault protection.
  - 1. Serial communication fault protection.
  - m. Microprocessor fault.
  - n. Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per IEEE C62.41).
  - o. Visual display of specific fault conditions.
- 16. Operational Features:
  - a. Use manufacturer's standard unless otherwise indicated.
  - b. Sustained power loss.
  - c. Momentary power loss.
  - d. Power interruption.
  - e. Power loss ride through (0.1 second).
  - f. Start on the fly.
  - g. Electronic motor overload protection.
  - h. Stall protection.
  - i. Slip compensation.
  - j. Automatic restart after power return (ability to enable/disable function).

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- k. Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
- 1. Drive maintenance system software for complete programming and diagnostics.
- m. Ground fault protection, drive, and motor.
- n. Operate with no motor connected to output terminals.
- B. Rectifier: Three-phase 12-pulse (larger than 75 hp), full wave diode bridge rectifier to provide a constant dc voltage to the drive's dc bus.
- C. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.
- D. Controller: Microprocessor-controller PWM inverter to convert to dc voltage to variable voltage, adjustable frequency three-phase ac output. The output voltage shall vary proportionally with the frequency to maintain a constant ratio of volts to hertz up to 60-Hz. Above 60-Hz, the voltage shall remain constant, with the drive operating in a constant horsepower output mode. Provide filters in the inverter output circuit to minimize the impact of fast rise time switching pulses associated with PWM drives.
- E. Conformal Coating Requirements: All electronic circuit boards and components shall have a UL recognized conformal coating that meets the Military's MIL-I-46058C specification. The coating shall provide for moisture and environmental protection. All electronic circuit boards shall be impervious to moisture, fungus, dust and corrosive atmospheres such as Hydrogen Sulfide and other environmental contaminants. Terminal pins and connectors shall be masked off such that the coating shall not impede operation. The coating shall be applied to both sides and all edges of the electronic circuit boards.
- F. Enclosure:
  - 1. NEMA 250, Type 12, gasketed, freestanding, enclosure for mounting against wall, completely front accessible, and hinged doors. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure not to exceed dimensions shown on the Drawings.
  - 2. Furnish drive complete with cable termination compartment door with a flanged mounted disconnect interlocked main circuit breaker, defeatable (lockable in the open position), emergency stop pushbutton, alphanumeric keypad and display, and operator's controls. Components and controls specified in Section 26 05 04, Basic Electrical Materials and Methods.

- 3. Wire drive from below and above for power and control wiring.
- 4. Size forced-ventilation for periodic operation to cool each unit with maximum room ambient temperature of 95 degrees F. Furnish redundant fans such that if one fan fails remaining fans furnish adequate ventilation for the drive when operating at maximum capacity. Furnish filters on ventilation intakes.
- 5. Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding; label each terminal for permanent identification of leads; identify each wire at each end with imprinted mylar adhesive-back wire markers; incorporate in as-installed wiring diagrams for wire and terminal numbers shown; wiring across door hinges use 19-strand, NEMA WC-57 Class C stranding looped for proper twist rather than bending at hinge; wire connections internal to panels by crimp-on terminal types. For multiple enclosure systems, complete interconnection wiring with gasketed enclosure openings for wiring; multipoint plug receptacles for any control wiring crossing equipment shipping splits.
- 6. Selector switches, indicating lights, potentiometers, instruments, protective devices, major system components, etc., identified by means of mechanically attached, engraved, laminated nameplates.
- G. Operator Interface:
  - 1. Controls: Mount drive local control on front door of enclosure and include control switch and membrane type keypad for the following operator functions:
    - a. Start (when in local mode).
    - b. Stop (when in local mode).
    - c. Speed increase (when in local mode).
    - d. Speed decrease (when in local mode).
    - e. Parameter mode selection (recall programmed parameters).
    - f. LOCAL/OFF/REMOTE control selection (in remote, furnish for remote RUN command and speed increase/decrease via hardwired communication interface).
    - g. Fault reset, manual for all faults (except loss of ac voltage which is automatic upon return).
    - h. RUN/preset speed.
    - i. Parameter lock (password or key switch lockout of changes to parameters).
    - j. Start disable (key switch or programmed code).
  - 2. 120 volts, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer. Furnish power for motor space heaters rated 120 volts. Switch motor space heater circuits on when drive is not running.

#### SWF BAF IMPROVEMENTS

- 3. Arrange component and circuit such that failure of any single component cannot cause cascading failure(s) of any other component(s).
- 4. Alphanumeric Display: During normal operation and routine test, the following parameters shall be available:
  - a. Motor current (percent of motor full load current).
  - b. Motor torque (percent of motor full load torque).
  - c. Output frequency (Hertz).
  - d. Output voltage.
  - e. Running time.
  - f. Local/remote indicator.
  - g. Status of digital inputs and outputs.
  - h. Analog input and output values.
  - i. Output motor current per leg.
  - j. All test points.
- 5. Adjustable Parameters: Set drive operating parameters and indicate in a numeric form. Potentiometers may not be used for parameter adjustment. Minimum setup parameters available:
  - a. Frequency range, minimum, maximum.
  - b. Adjustable acceleration/deceleration rate.
  - c. Volts per Hertz (field weakening point).
  - d. Active current limit/torque limit, 0 to 140 percent of drive rating.
  - e. Adjustable voltage boost (IR compensation).
  - f. Preset speed (adjustable, preset operating point).
  - g. Provision for adjustment of minimum and maximum pump speed to be furnished as function of 4 to 20 mA remote speed signal.
- 6. Control Diagrams: For control logic and interlock requirements, see applicable control diagrams shown on the Contract Drawings.
- H. Signal Interface:
  - 1. Digital Input:
    - a. Accept a remote RUN command contact closure input.
    - b. High temperature contact closure input from field mounted motor temperature monitoring relay.
  - 2. Digital Output: Furnish three discrete output dry contact closures rated 5 amps at 120 volts ac.
    - a. DRIVE RUNNING.
    - b. DRIVE FAULT (with common contact closure for all fault conditions).
    - c. DRIVE IN REMOTE MODE.
  - 3. Analog Input: When LOCAL/OFF/REMOTE switch is in REMOTE, control drive speed from remote 4 mA to 20 mA dc signal.
    - a. Make provisions for adjustment of minimum and maximum motor speed which shall result from this signal.

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- b. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications.
- c. Frequency resolution shall be 0.1 percent of base speed.
- 4. Analog Output: Furnish two 4 mA to 20 mA dc signals for actual frequency, actual load.
- I. Communication: Ethernet Module MODBUS TCP/IP
- J. Provide output reactor or dV/Dt filter limit voltage spikes at the motor as recommended by manufacturer and/or as shown on the Drawings.
- K. Accessories:
  - 1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
  - 2. Lifting Lugs: Equipment weighing over 100 pounds.
  - 3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

## 2.04 FACTORY FINISHING

- A. Enclosure:
  - 1. Primer: One coat of rust-inhibiting coating.
  - 2. Finish:
    - a. Interior: One coat white enamel.
    - b. Exterior: One coat manufacturer's standard gray enamel or TIA/EIA 359-1, No. 61.

### 2.05 PROJECT SPECIFIC REQUIREMENTS

- A. For additional requirements, refer to the Contract Drawings.
- 2.06 SOURCE QUALITY CONTROL
  - A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
  - B. Factory Tests and Adjustments: Test one control panels identical to that furnished.
  - C. Record test data for report.
  - D. Functional Test: Perform manufacturer's standard.
  - E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

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## PART 3 EXECUTION

#### 3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

## 3.02 FIELD QUALITY CONTROL

- A. Functional Test:
  - 1. Conduct on each controller.
  - 2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
  - 3. Vibration Test: Support pump manufacturer testing of the complete assembly, consisting of motor, load, and flexible shafting, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by current edition of Hydraulic Institute Standards. Where loads and drives are separated by intermediate flexible shafting, measure vibration both at top motor bearing and at two points on top pump bearing, 90 degrees apart.
  - 4. Record test data for report.
- B. Performance Test:
  - 1. Conduct on each controller.
  - 2. Perform under actual or approved simulated operating conditions.
  - 3. Test for continuous 12-hour period without malfunction.
  - 4. Demonstrate performance by operating the continuous period while varying the application load, as the input conditions allow, to verify system performance.
  - 5. Record test data for report.
  - 6. With plant load connected to normal utility source, measure the following to show parameters within specified limits:
    - a. Total and individual current harmonic distortion (up to and including 35th harmonic) at Incoming Line Terminals of Existing Switchboard under following load conditions:
      - 1) VFDs running at full load and half load.
      - 2) Half of the specified VFDs running at full load and half load.
    - b. Power factor at input side of each drive. Documented verification that power factor is maintained at 95 percent as speed of drive goes down from 100 percent to 33 percent.
    - c. Individual and total voltage harmonic distortion at Incoming Line Terminals of Existing Switchboard under following conditions:
      - 1) VFDs running at full load and half load.
      - 2) Half of specified VFDs running at full load and half load.

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- C. Test Equipment:
  - 1. Provide diagnostic plug-in test card complete with instructions, multiposition selector switch, and meters or built-in diagnostic control panel or ROM-based processor for monitoring ac, dc, and digital signals to assist in troubleshooting and startup of drive.
  - 2. Use Dranete/BMI, Model No. 658, disturbance analyzer or equivalent instrument to document results.
  - 3. The test setup for the disturbance analyzer shall include any PTs, CTs, and other auxiliaries required to properly record harmonic disturbance data.
- D. Performance Test:
  - 1. Conduct on each controller.
  - 2. Perform under actual or approved simulated operating conditions.
  - 3. Test for continuous 12-hour period without malfunction.
  - 4. Demonstrate performance by operating the continuous period while varying the application load, as the input conditions allow, to verify system performance.
  - 5. Record test data for report.

## 3.03 MANUFACTURERS' SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
  - 1. 1 person-day for installation assistance and inspection.
  - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
  - 3. 1/2 person-day for prestartup classroom or Site training.
  - 4. 1/2 person-day for facility startup.
  - 5. 1/2 person-day for post-startup training. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Engineer.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

# END OF SECTION

# SECTION 26 43 00 SURGE PROTECTIVE DEVICES

# PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American National Standards Institute (ANSI).
  - 2. Department of Defense: MIL-STD-220C, Test Method Standard Method of Insertion Loss Measurement.
  - 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
    - b. C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and less) AC Power Circuits.
    - c. C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and less) AC Power Circuits.
  - 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 5. UL:
    - a. 497A, Standard for Secondary Protectors for Communications Circuits.
    - b. 1283, Standard for Electromagnetic Interference Filters.
    - c. 1449, Standard for Surge Protective Devices.

# 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
  - 2. Electrical single-line diagram showing location of each surge protective device (SPD).
  - 3. Manufacturer's UL certified test data and nameplate data for each SPD.

#### SWF BAF IMPROVEMENTS

### 1.03 QUALITY ASSURANCE

- A. UL Compliance and Labeling:
  - 1. SPDs for Power and Signal Circuits: Comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units listed and labeled by UL.
  - 2. SPDs for Telephone Circuit Protection: Comply with UL 497A.
- B. ANSI Compliance: Use SPD devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

## PART 2 PRODUCTS

#### 2.01 MANUFACTURER

- A. General Electric, Tranquell.
- B. Square D, Surelogic.
- C. Advanced Protection Technologies, Inc.
- D. CITEL, MDS Series.
- E. "Or-Equal" Approved.

#### 2.02 GENERAL

- A. Unless indicated otherwise, provide direct bus-connected and factory-installed SPDs inside distribution equipment.
- B. SPD Operating Conditions: Capable of performing at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.
- C. Connect SPDs through a fused switch or circuit breaker as selected by manufacturer. Provide overcurrent protection to allow full surge handling capabilities and afford safety protection from thermal overloads and short circuits.
- D. SPD Short Circuit Current Rating (SCCR): No less than the SCCR of distribution equipment.
- E. Design SPD devices to protect all modes (L-L, L-N, L-G, N-G) of electrical system being used.

- F. Power Filter: Include a high-frequency extended range power filter for each SPD complimentary listed to UL 1283 as an electromagnetic interference filter.
- G. Provide SPDs with the following monitoring and diagnostics:
  - 1. LED-type indication lights to show normal and failed status of each protected phase.
  - 2. Surge event counter.
  - 3. Form C dry contact which operates when unit fails.
- H. Provide UL Type 2 SPDs.
- I. EMI/RFI Noise Suppression: -50dB attenuation at 100 kHz, tested per MIL-STD 220C.
- J. Voltage Protection Rating (VPR):

Voltage Rating	L-N	N-G	L-G	L-L
208Y/120	800	800	800	1200
480Y/277	1200	1200	1200	2000
240 Δ			1200	1200
$480 \Delta$			2000	2000

#### 2.03 SERVICE ENTRANCE AND DISTRIBUTION SPD

- A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.
- B. Surge Current Capacity:
  - 1. Service Entrance: 240 kA per phase.
  - 2. Distribution: 160 kA per phase.
- C. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system voltage.
- D. Nominal Discharge Current (I<sub>N</sub>): 20kA.

#### 2.04 PANELBOARD SPD

A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category B.

- B. Surge Current Capacity:
  - 1. Distribution: 160 kA per phase.
  - 2. Branch: 120 kA per phase.
- C. Maximum Continuous Operating Voltage (MCOV): Not less than 125 percent of the nominal system voltage.
- D. Nominal Discharge Current (I<sub>N</sub>): 10kA.

#### 2.05 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Use bi-polar 1,500-watt silicon avalanche diodes between protected conductor and earth ground.
- C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).
- D. Breakdown voltage shall not exceed 36 volts.

## 2.06 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Design Requirements: A hybrid design with a minimum of three stages, using solid-state components and operating bi-directionally.
- C. Meet or exceed the following criteria:
  - 1. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
  - 2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform); 2,000 occurrences.
  - 3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of normal applied signal voltage by 200 percent.

# PART 3 EXECUTION

#### 3.01 APPLICATION REQUIREMENTS

A. Provide SPDs when indicated on the Drawings or in the equipment specifications.

- B. Provide factory-installed SPDs as integral components to new switchgear, switchboards, motor control centers, panelboards and transfer switches.
  Externally mounted SPDs are not acceptable for new distribution equipment.
- C. Externally mounted SPDs are acceptable for SPDs added to existing equipment as described below.
- D. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.
  - 1. Use secondary protectors on lines that do not exit the structure.
  - 2. Use primary protectors on lines that exit and enter the structure.

#### 3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install suppressors according to manufacturer's recommendations.
- B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.
- C. Provide connecting wires as short as possible with gently twisted conductors, tied together, to prevent separation.
  - 1. Maximum Length: 24 inches.
- D. Field Installed Conductors: As specified for building wire, not smaller than 8 AWG and not larger than 4 AWG. Provide device leads not longer than the maximum length recommended by manufacturer, unless specifically reviewed and approved by manufacturer.
- E. Provide dedicated disconnecting means for SPD devices installed at main service entrance location, switchgear, and motor control centers. Provide dedicated 30-60-ampere circuit breakers (size dependent upon wire size used) with number of poles as required, as disconnecting means for SPD devices. Provide circuit breakers with interrupting capacity equal to that specified for other breakers at that location.

# **END OF SECTION**

# SECTION 31 10 00 SITE CLEARING

# PART 1 GENERAL

## 1.01 DEFINITIONS

- A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.
- D. Project Limits: Areas, as shown or specified, within which Work is to be performed.

# 1.02 QUALITY ASSURANCE

A. Obtain Engineer's approval of staked clearing and grubbing limits, prior to commencing clearing and grubbing.

#### 1.03 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls.

# PART 2 PRODUCTS (NOT USED)

# PART 3 EXECUTION

#### 3.01 GENERAL

- A. Clear and grub areas actually needed for site improvements within limits shown or specified.
- B. Do not injure or deface vegetation that is not designated for removal.

- 3.02 LIMITS
  - A. As follows, but not to extend beyond Project limits.
    - 1. Excavation 4 feet beyond top of cut slopes.
    - 2. Fill:
      - a. Clearing and Grubbing: 4 feet beyond toe of permanent fill.
  - B. Remove rubbish, trash, and junk from entire area within Project limits.
- 3.03 CLEARING
  - A. Clear areas within limits shown or specified.
  - B. Fell trees so that they fall away from facilities and vegetation not designated for removal.
  - C. Cut stumps not designated for grubbing to within 6 inches of ground surface.
  - D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

#### 3.04 GRUBBING

A. Grub areas within limits shown or specified.

#### 3.05 DISPOSAL

- A. Clearing and Grubbing Debris:
  - 1. Dispose of debris offsite.
  - 2. Burning of debris onsite will not be allowed.
  - 3. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.

# **END OF SECTION**

# SECTION 31 23 13 SUBGRADE PREPARATION

# PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).

## 1.02 DEFINITIONS

- A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.
- B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
- C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.
- D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.
- E. Subgrade: Layer of existing soil after completion of clearing and grubbing, prior to placement of fill, roadway structure or base for floor slab.
- F. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

# 1.03 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

# PART 2 PRODUCTS (NOT USED)

### PART 3 EXECUTION

#### 3.01 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.

#### 3.02 COMPACTION

- A. Under Earthfill: Compact upper 8 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.
- B. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Compact the upper 8inches to minimum of 98 percent relative compaction as determined in accordance with ASTM D1557.

#### 3.03 MOISTURE CONDITIONING

- A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
- B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

#### 3.04 TESTING

A. Proof-roll subgrade to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

#### 3.05 CORRECTION

- A. Soft or Loose Subgrade:
  - 1. Adjust moisture content and recompact, or
  - 2. Over excavate and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

SUBGRADE PREPARATION 31 23 13 - 2

PW\JACOBS AMERICAS\D3418006 FEBRUARY 27, 2023 ©COPYRIGHT 2023 JACOBS B. Unsuitable Material: Over excavate and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

# **END OF SECTION**

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# SECTION 31 23 23 FILL AND BACKFILL

# PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
    - b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
    - c. D75, Standard Practice for Sampling Aggregates.
    - d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
    - f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
    - g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
    - h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
    - i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

# 1.02 DEFINITIONS

- A. Relative Compaction:
  - 1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
  - 2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.
- B. Optimum Moisture Content:
  - 1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

- 2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.
- C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.
- D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.
- E. Completed Course: A course or layer that is ready for next layer or next phase of Work.
- F. Lift: Loose (uncompacted) layer of material.
- G. Geosynthetics: Geotextiles, geogrids, or geomembranes.
- H. Well-Graded:
  - 1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
  - 2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
  - 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
- I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
  - 1. 1 foot outside outermost edge at base of foundations or slabs.
  - 2. 1 foot outside outermost edge at surface of roadways or shoulder.
  - 3. 0.5 foot outside exterior at spring line of pipes or culverts.
- J. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.
- K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.
- L. Imported Material: Materials obtained from sources offsite, suitable for specified use.
- M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

#### 1.03 SUBMITTALS

A. Informational Submittals: Certified test results from independent testing agency.

## 1.04 QUALITY ASSURANCE

- A. Notify Engineer when:
  - 1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
  - 2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
  - 3. Fill material appears to be deviating from Specifications.

## 1.05 SEQUENCING AND SCHEDULING

- Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 10, Structural Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.
- B. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

# PART 2 PRODUCTS

#### 2.01 SOURCE QUALITY CONTROL

- A. Gradation Tests: As necessary to locate acceptable sources of imported material.
- B. Samples: Collected in accordance with ASTM D75.

#### 2.02 EARTHFILL

- A. Excavated material from required free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.
- B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.

#### SWF BAF IMPROVEMENTS

#### 2.03 GRANULAR FILL

- A. 1-inch minus crushed gravel or crushed rock.
- B. Free from dirt, clay balls, and organic material.
- C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

#### 2.04 SAND

- A. Free from clay, organic matter, or other deleterious material.
- B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

#### 2.05 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

#### 2.06 BASE COURSE ROCK

- A. As specified in Section 32 11 23, Aggregate Base Courses.
- B. Access Road Surfacing: Gradation same as for base course.

#### PART 3 EXECUTION

#### 3.01 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.
- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
  - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
  - 2. Excavate trench for installation of item.
  - 3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
  - 4. Install item.
  - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.
- F. Tolerances:
  - 1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
  - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

#### 3.02 BACKFILL UNDER AND AROUND STRUCTURES

- A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D1557.
- B. Other Areas: Backfill with earthfill or granular fill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 98 percent relative compaction as determined in accordance with ASTM D1557.

## 3.03 FILL

- A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
  - 1. Allow for 4-inch thickness of topsoil where required.
  - 2. Maximum 8-inch thick lifts.
  - 3. Place and compact fill across full width of embankment.
  - 4. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.
  - 5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

#### 3.04 SITE TESTING

- A. Gradation: Remove material placed in Work that does not meet Specification requirements.
- B. In-Place Density Tests: In accordance with ASTM D1556.

## 3.05 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base Courses.

#### 3.06 REPLACING OVEREXCAVATED MATERIAL

- A. Replace excavation carried below grade lines shown or established by Engineer as follows:
  - 1. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
  - 2. Beneath Slabs-On-Grade: Granular fill.
  - 3. Trenches:
    - a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
    - b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
  - 4. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
    - a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.

- b. Steep Slopes (Steeper than 3:1):
  - Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
  - 2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

# 3.07 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base Courses.

# **END OF SECTION**

# SECTION 31 23 23.15 TRENCH BACKFILL

## PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Public Works Association (APWA): Uniform Color Code.
  - 2. ASTM International (ASTM):
    - a. C33/C33M, Standard Specification for Concrete Aggregates.
    - b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
    - c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
    - d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
    - e. C150/C150M, Standard Specification for Portland Cement.
    - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
    - g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
    - h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
    - j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
    - k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
    - 1. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
    - m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
    - n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
    - o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
  - 3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

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#### 1.02 DEFINITIONS

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- C. Imported Material: Material obtained by Contractor from source(s) offsite.
- D. Lift: Loose (uncompacted) layer of material.
- E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.
- F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.
- G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.
- H. Relative Density: As defined by ASTM D4253 and ASTM D4254.
- I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.
- J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:
  - 1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
  - 2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.
- K. MIU Standards: Marco Island Utilities Technical Standards Manual, latest edition.

L. FDOT: Florida Department of Transportation Specifications for Road and Bridge Construction, latest edition.

## 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings: Manufacturer's descriptive literature for marking tapes.
- B. Informational Submittals:
  - 1. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
  - 2. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

# PART 2 PRODUCTS

- 2.01 GENERAL
  - A. Trench products and installation shall be in accordance with MIU Standards. Products shall be selected from the MIU Standards List of Approved Materials and Manufacturers (Appendix D).

#### 2.02 GEOTEXTILE

A. In accordance with MIU Standards, Mirafi FW402 Woven Geotextile or preapproved equal.

# 2.03 MARKING TAPE

- A. Detectable:
  - 1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
  - 2. Foil Thickness: Minimum 0.35 mils.
  - 3. Laminate Thickness: Minimum 5 mils.
  - 4. Width: 3 inches.
  - 5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
  - 6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.

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- 7. Manufacturers and Products:
  - a. Reef Industries; Terra Tape, Sentry Line Detectable.
  - b. Mutual Industries; Detectable Tape.
  - c. Presco; Detectable Tape.
- B. Color: In accordance with APWA Uniform Color Code.

Color*	Facility	
Red	Electric power lines, cables, conduit, and lightning cables	
Orange	Communicating alarm or signal lines, cables, or conduit	
Yellow	Gas, oil, steam, petroleum, or gaseous materials	
Green	Sewers and drain lines	
Blue	Potable water	
Purple	Reclaimed water, irrigation, and slurry lines	
*As specified in NEMA Z535.1, Safety Color Code.		

#### 2.04 TRENCH STABILIZATION MATERIAL

A. Base Rock: In accordance with MIU Standards, FDOT No. 57 Stone.

#### 2.05 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832 and FDOT specifications.
- 2.06 GRAVEL SURFACING ROCK
  - A. As specified in Section 32 11 23, Aggregate Base Courses.
- 2.07 SOURCE QUALITY CONTROL
  - A. Perform gradation analysis in accordance with ASTM C136 for:
    - 1. Earth backfill, including specified class.
    - 2. Trench stabilization material.
    - 3. Bedding and pipe zone material.
  - B. Certify Laboratory Performance of Mix Designs: Controlled low strength material.

# PART 3 EXECUTION

#### 3.01 GENERAL

A. Trench excavation, pipe placement and backfill shall be in accordance with MIU Standards.

## 3.02 SHEETING AND BRACING

A. In order to prevent damage to property, injury to persons, erosion, cave-in or excessive trench width, adequate sheeting and bracing shall be provided per regulations of the Federal Occupational Safety and Health Administration and/or as directed by the Owner or Engineer. Contractor shall comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc. This Work shall be performed in accordance with accepted standard practice when design consideration warrants due to adverse soil condition, proximity of existing utilities, maintenance and protection of traffic. Sheeting shall be removed when the trench has been backfilled to at least one-half its depth or when removal would not endanger the construction of adjacent structures. When required to eliminate excessive trench width or other damage, shoring or bracing shall be left in place and the top cut off at an elevation 2.5-feet below finished grade, unless otherwise directed.

# 3.03 TRENCH PREPARATION

- A. Water Control and Dewatering:
  - 1. Contractor shall be responsible for all applicable state and local regulations regarding offsite discharge of water and turbidity control.
  - 2. Water shall not be allowed in the trenching while the pipes are being laid and/or tested. The Contractor shall not open more trench than the available pumping facilities are able to dewater to the satisfaction of MIU.
  - 3. If surface water is encountered, the Contractor shall use approved means to dewater the excavation. A well point system or other approved equipment shall be installed if necessary to maintain the excavation in a dry condition for placing of concrete and setting pipelines. The Contractor shall assume responsibility for disposing of all water so as not to injure or interfere with the normal drainage of the territory.
  - 4. In no case shall the pipelines being installed be used as drains for such water and the ends of the pipe shall be kept properly and adequately blocked during construction using approved stoppers, and not improvised equipment.

- 5. All necessary precautions shall be taken to prevent the entrance of mud, sand, or other obstruction matter into the pipelines. If on completion of the work any such material has entered the pipelines, they shall be cleaned so that the entire system will be left clean and unobstructed.
- 6. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
- 7. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
- 8. Provide continuous water control until trench backfill is complete.
- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

## 3.04 TRENCH BOTTOM

- A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.
- B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.
- 3.05 GEOTEXTILE INSTALLATION
  - A. In accordance with MIU Standards and Trench and Paving Restoration Detail CB-10.

#### 3.06 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.
- B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.
- C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.
- 3.07 BEDDING
  - A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

- B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
- D. Minimum Thickness:
  - 1. Pipe: 8 inches.
  - 2. Conduit: 4 inches.
  - 3. Direct-Buried Cable: 4 inches.
  - 4. Duct Banks: 4 inches.
- E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

#### 3.08 BACKFILL PIPE ZONE

- A. Backfill of the pipe zone shall be in two layers in accordance with MIU Standards and Trench and Paving Restoration Detail CB-10.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
- D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

#### 3.09 MARKING TAPE INSTALLATION

A. Continuously install marking tape in two vertical rows along centerline of buried piping as shown in MIU Standards Trench and Paving Restoration Detail CB-10. Coordinate with piping installation drawings.

#### SWF BAF IMPROVEMENTS

## 3.10 BACKFILL ABOVE PIPE ZONE

#### A. General:

- 1. Process excavated material to meet specified gradation requirements.
- 2. Adjust moisture content as necessary to obtain specified compaction.
- 3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
- 4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
- 5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
- 6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.
- B. Controlled Low Strength Material:
  - 1. Discharge from truck mounted drum type mixer into trench.
  - 2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

#### 3.11 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 6 inches of backfilled trench.
- B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

#### 3.12 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

#### 3.13 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

# **END OF SECTION**
## SECTION 32 11 23 AGGREGATE BASE COURSES

## PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. C29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
    - b. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
    - c. C117, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing.
    - d. C131, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
    - e. C183, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
    - f. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - g. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft<sup>3</sup> (2700 kN-m/m<sup>3</sup>)).
    - h. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
    - i. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
    - j. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
    - k. D2844, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
    - 1. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
    - m. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
    - n. D5195, Standard Test Methods for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.
    - o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

### 1.02 DEFINITIONS

- A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.
- B. Completed Lift: Compacted with uniform cross-section thickness.
- C. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.
- D. Gravel Surfacing: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.
- E. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.
- F. Standard Specifications: When referenced in this section, shall mean Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
- G. Subbase Course: Sandy, gravelly material placed and compacted on prepared subgrade.

### 1.03 SUBMITTALS

- A. Informational Submittals:
  - 1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
  - 2. Certified results of in-place density tests from independent testing agency.

## PART 2 PRODUCTS

- 2.01 BASE COURSE
  - A. As specified for Section 204, Graded Aggregate Base, Section 230, Limerock Stabilized Base, of the Standard Specifications.
  - B. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.
  - C. Crushed Recycled Concrete: Base course may consist of crushed recycled concrete consisting of previously hardened Portland cement concrete or other concrete containing pozzolanic binder material. Provide recycled material free of all reinforcing steel, bituminous concrete surfacing, and any other foreign material, crushed and processed to meet gradation requirements below. Crushed material may be blended with native aggregate. Base course utilizing crushed concrete must meet requirements for aggregate base course.

AGGREGATE BASE COURSES 32 11 23 - 2

## 2.02 GRAVEL SURFACING

- A. Match existing size, color and type of granite/river rock found onsite that is used as gravel surfacing. In general, the size is No. 57 stone and composed of a mixture of granite rock and river rock.
- B. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring either free or as coating on stone.

## 2.03 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

# PART 3 EXECUTION

## 3.01 SUBGRADE PREPARATION

- A. As specified in Section 31 23 13, Subgrade Preparation.
- B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

## 3.02 EQUIPMENT

A. In accordance with the Standard Specifications.

## 3.03 HAULING AND SPREADING

- A. In accordance with the Standard Specifications.
- B. Hauling Materials:
  - 1. Do not haul over surfacing in process of construction.
  - 2. Loads: Of uniform capacity.
  - 3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.
- C. Spreading Materials:
  - 1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
  - 2. Produce even distribution of material upon roadway or prepared surface without segregation.
  - 3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

### SWF BAF IMPROVEMENTS

### 3.04 CONSTRUCTION OF COURSES

- A. Construction of Courses: In accordance with the Standard Specifications.
- B. Base Course:
  - 1. Maximum Completed Lift Thickness: 6 inches.
  - 2. Completed Course Total Thickness: As shown.
  - 3. Spread lift on preceding course to required cross-section.
  - 4. Lightly blade and roll surface until thoroughly compacted.
  - 5. Add keystone to achieve compaction and as required when aggregate does not compact readily because of lack of fines or natural cementing properties, as follows:
    - a. Use leveling course or surfacing material as keystone.
    - b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
    - c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
    - d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
  - 6. Blade or broom surface to maintain true line, grade, and cross-section.
- C. Gravel Surfacing:
  - 1. Completed Course Total Thickness: As shown.
  - 2. Spread on preceding course in accordance with cross-section shown.
  - 3. Blade lightly and roll surface until material is thoroughly compacted.

#### 3.05 ROLLING AND COMPACTION

- A. In accordance with Section the Standard Specifications.
- B. Commence rolling at outer edges and continue toward center; do not roll center of road first.
- C. Apply water as needed to obtain specified densities.
- D. Place and compact each lift to the required density before succeeding lift is placed.
- E. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.
- F. Finished surface shall be true to grade and crown before proceeding with surfacing.

### 3.06 SURFACE TOLERANCES

- A. Blade or otherwise work surfacing as necessary to maintain grade and crosssection at all times, and to keep surface smooth and thoroughly compacted.
- B. Finished Surface of Untreated Aggregate Base Course: Within plus or minus 0.04 foot of grade shown at any individual point.
- C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.
- D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

## 3.07 FIELD QUALITY CONTROL

- A. In-Place Density Tests:
  - 1. Show proof that areas meet specified requirements before: identifying density test locations.
  - 2. Refer to Table 2 for minimum sampling and testing requirements for aggregate base course and surfacing.

Table 2   Minimum Sampling and Testing Requirements			
Property	Test Method	Frequency	Sampling Point
Gradation	ASTM C117and ASTM C183	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	ASTM D1557, Method D	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	ASTM D5195, ASTM D6938, and ASTM D2216 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

### 3.08 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

### **END OF SECTION**

# SECTION 32 12 16 ASPHALT PAVING

## PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Association of State Highway and Transportation Officials (AASHTO):
    - a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
    - b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
    - c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
    - d. M140, Standard Specification for Emulsified Asphalt.
    - e. M156, Standard Specification for Requirements for Mixing Plants for Hot-mixed, Hot-laid Bituminous Paving Mixes.
    - f. M208, Standard Specification for Cationic Emulsified Asphalt.
    - g. R35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.
    - h. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
    - i. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
    - j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA).
    - k. T245, Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus.
    - 1. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA) by Means of Hveem Apparatus.
    - m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
    - n. T283, Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage.
    - o. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate.
    - p. T312, Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of a Superpave Gyratory Compactor.

- 2. Asphalt Institute (AI):
  - a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
  - b. Superpave Series No. 2 (SP-2), Superpave Mix Design.
- 3. ASTM International (ASTM):
  - a. D75, Standard Method of Test for Sampling of Aggregates.
  - b. D140, Standard Method of Test for Sampling Bituminous Materials.
  - c. D979, Standard Method of Test for Sampling Bituminous Paving Mixtures.
  - d. D2041, Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
  - e. D2489, Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures.
  - f. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  - g. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
  - h. D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
  - i. E329 REV A, Standard Specification for Agencies Engaged in Construction Inspection Testing, or Special Inspection.

### 1.02 DEFINITIONS

- A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.
- B. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.
- C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.
- D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.
- E. Reclaimed asphalt pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.
- F. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.

- G. Standard Specifications: Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
- H. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.

## 1.03 DESIGN REQUIREMENTS

A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of this Specification.

### 1.04 SUBMITTALS

- A. Informational Submittals:
  - 1. Asphalt Concrete Mix Formula.
  - 2. Test Report for Asphalt Cement:
    - a. Submit minimum 10 days prior to start of production.
    - b. Show appropriate test method(s) for each material and the test results.
  - 3. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following materials:
    - a. Aggregate: Gradation and source test results
    - b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
    - c. Prime Coat: Type and grade of asphalt.
    - d. Tack Coat: Type and grade of asphalt.
    - e. Additives.
    - f. Mix: Conforms to job-mix formula.
  - 4. Statement of qualification for independent testing laboratory.
  - 5. Test Results:
    - a. Mix design.
    - b. Asphalt concrete core.
    - c. Gradation and asphalt content of uncompacted mix.
    - d. Field density.
    - e. Quality control.

### 1.05 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Independent Testing Laboratory: In accordance with ASTM E329 REV A.
  - 2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

### SWF BAF IMPROVEMENTS

### 1.06 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F or air temperature is lower than 40 degrees F. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.
- B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

A. Tack Coat: Conform to Section 300, Prime and Tack Coats, of the Standard Specifications.

### 2.02 ASPHALT CONCRETE MIX

- A. General: Mix formula shall not be modified except with written approval of Jacobs.
- B. Asphalt Concrete: Type S-1 as specified by City of Marco Island.

### PART 3 EXECUTION

#### 3.01 GENERAL

- A. Traffic Control:
  - 1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
  - 2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.
- B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

#### 3.02 LINE AND GRADE

- A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.
- B. Shoulders: Construct to line, grade, and cross-section shown.

## 3.03 APPLICATION EQUIPMENT

A. In accordance with Section 330, Hot Mix Asphalt – General Construction Requirements, of the Standard Specifications.

### 3.04 PREPARATION

- A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.
- B. Existing Roadway:
  - 1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
  - 2. Remove existing material to a minimum depth of 1 inch.
  - 3. Paint edges of meet line with tack coat prior to placing new pavement.
- C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

## 3.05 PAVEMENT APPLICATION

- A. General: Place asphalt concrete mixture on approved, prepared base in conformance with Section 330, Hot Mix Asphalt General Construction Requirements, of the Standard Specifications.
- B. Pavement Mix:
  - 1. Prior to Paving:
    - a. Sweep primed surface free of dirt, dust, or other foreign matter.
    - b. Patch holes in primed surface with asphalt concrete pavement mix.
    - c. Blot excess prime material with sand.
  - 2. Place asphalt concrete pavement mix in one single lift.
  - 3. Compacted Lift Thickness:
    - a. Minimum: Twice maximum aggregate size, but in no case less than 1 inch.
    - b. Maximum: 4 inches.
  - 4. Total Compacted Thickness: As shown.
  - 5. Sequence placement so that meet lines are straight and edges are vertical.
  - 6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

- 7. Joints:
  - a. Offset edge of each layer a minimum of 6 inches so joints are not directly over those in underlying layer.
  - b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
  - c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
- 8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
- 9. After placement of pavement, seal meet line by painting a minimum of 6 inches on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.
- C. Tolerances:
  - 1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
  - 2. Completed Surface or Wearing Layer Smoothness:
    - a. Uniform texture, smooth, and uniform to crown and grade.
    - b. Maximum Deviation: 1/8 inch from lower edge of a 12-foot (3.6-meter) straightedge, measured continuously parallel and at right angle to centerline.
    - c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.

## 3.06 PATCHING

- A. Preparation:
  - 1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
  - 2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

## B. Application:

- 1. Patch Thickness: As shown or thickness of adjacent asphalt concrete, whichever is greater.
- 2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
- 3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

- C. Compaction:
  - 1. Roll patches with power rollers capable of providing compression of 200 pounds per linear inch to 300 pounds per linear inch (350 Newtons per linear centimeter to 525 Newtons per linear centimeter). Use hand tampers where rolling is impractical.
  - 2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least one-half the roller width. Progress toward center of patch overlapping each preceding track by at least one-half width of roller.
  - 3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.
- D. Tolerances:
  - 1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
  - 2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch (6 millimeters) or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

## 3.07 FIELD QUALITY CONTROL

- A. General: Provide services of approved certified independent testing laboratory to conduct tests.
- B. Field Density Tests:
  - 1. Perform tests from cores or sawed samples in accordance with AASHTO T166.
  - 2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
  - 3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.
  - 4. Density Tests: Once every 500 tons of mix or once every 4 hours, whichever is greater.

## **END OF SECTION**

## SECTION 32 92 00 TURF AND GRASSES

## PART 1 GENERAL

## 1.01 DEFINITIONS

- A. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 6 weeks after all planting under this section is completed.
- B. Satisfactory Stand:
  - 1. No bare spots larger than 3 square feet.
  - 2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
  - 3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

## 1.02 SUBMITTALS

- A. Action Submittals: Product labels/data sheets.
- B. Informational Submittals:
  - 1. Seed: Certification of seed analysis, germination rate, and inoculation:
    - a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
      - 1) Name and address of laboratory.
      - 2) Date of test.
      - 3) Lot number for each seed specified.
      - Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
      - b. Mixtures: Proportions of each kind of seed.
  - 2. Certification of sod; include source and harvest date of sod, and sod seed mix.
  - 3. Certification of sod type and name.
  - 4. Description of required maintenance activities and activity frequency.

### SWF BAF IMPROVEMENTS

### 1.03 DELIVERY, STORAGE, AND PROTECTION

- A. Temporary Seed (during construction):
  - 1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
  - 2. Keep dry during storage.
- B. Sod:
  - 1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.
  - 2. Harvest and deliver sod only after laying bed is prepared for sodding.
  - 3. Roll or stack to prevent yellowing.
  - 4. Deliver and lay within 24 hours of harvesting.
  - 5. Keep moist and covered to protect from drying from time of harvesting until laid.

### 1.04 SEQUENCING AND SCHEDULING

A. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice.

### 1.05 MAINTENANCE SERVICE

- A. Contractor: Perform maintenance operations during maintenance period to include:
  - 1. Watering: Keep surface moist.
  - 2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
  - 3. Mulch: Replace wherever and whenever washed or blown away.
  - 4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
  - 5. Re-sod unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.

## PART 2 PRODUCTS

### 2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.

- B. Application Rates: Determined by soil analysis results.
- C. Top Dress Type: As recommended by local authority.

# 2.02 SEED (TEMPORARY DURING CONSTRUCTION)

- A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.
- B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer's instructions.
- C. Seed Mix: Annual Type Ryegrass with a minimum pure live seed content of 95 percent with a minimum germination of 90 percent.

## 2.03 SOD

- A. Certified, containing grass mix: Bahia.
- B. Strongly rooted pads, capable of supporting own weight and retaining size and shape when suspended vertically from a firm grasp on upper 10 percent of pad.
  - 1. Grass Height: Normal.
  - 2. Strip Size: Supplier's standard.
  - 3. Soil Thickness: Uniform; 1 inch plus or minus 1/4 inch at time of cutting.
  - 4. Age: Not less than 10 months or more than 30 months.
  - 5. Condition: Healthy, green, moist; free of diseases, nematodes and insects, and of undesirable grassy and broadleaf weeds. Yellow sod, or broken pads, or torn or uneven ends will not be accepted.

# PART 3 EXECUTION

## 3.01 PREPARATION

- A. Grade areas to smooth, even surface with loose, uniformly fine texture.
  - 1. Roll and rake, remove ridges, fill depressions to meet finish grades.
  - 2. Limit such Work to areas to be planted within immediate future.
  - 3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.
- B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

### 3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

### 3.03 SEEDING

A. Start within 2 days of preparation completion.

### 3.04 SODDING

- A. Do not plant dormant sod.
- B. Lay sod to form solid mass with tightly fitted joints; butt ends and sides, do not overlap.
  - 1. Stagger strips to offset joints in adjacent courses.
  - 2. Work from boards to avoid damage to subgrade or sod.
  - 3. Tamp or roll lightly to ensure contact with subgrade; work sifted soil into minor cracks between pieces of sod, remove excess to avoid smothering adjacent grass.
  - 4. Complete sod surface true to finished grade, even, and firm.
- C. Water sod with fine spray immediately after planting. During first week, water daily or more frequently to maintain moist soil to depth of 4 inches.
- D. Apply top dress fertilizer at recommended rate.

### 3.05 FIELD QUALITY CONTROL

- A. Six weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.
- B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

# **END OF SECTION**

## SECTION 33 05 01.10 HIGH-DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE AND FITTINGS

# PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
  - 1. American Society of Mechanical Engineers (ASME):
    - a. Boiler and Pressure Vessel Code, Section IX, Article XXI-XXIV.
    - b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
    - c. B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
    - d. B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
  - 2. American Water Works Association (AWWA):
    - a. C906, Polyethylene (PE) Pressure Piping and Fittings, 4 in. through 65 in. for Waterworks.
    - b. Manual M55, PE Pipe Design and Installation.
  - 3. ASTM International (ASTM):
    - a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
    - b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
    - c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    - d. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
    - e. A536, Standard Specification for Ductile Iron Castings.
    - f. A563, Standard Specification for Carbon and Alloy Steel Nuts.
    - g. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
    - h. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
    - i. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
    - j. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

- k. F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
- 1. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
- 4. Code of Federal Regulations (CFR): Title 49 Part 192.285, Plastic Pipe: Qualifying Persons to Make Joints.
- 5. NSF International (NSF): 61, Drinking Water System Components Health Effects.
- 6. Plastics Pipe Institute (PPI):
  - a. Handbook of PE Pipe.
  - b. Technical Note 38, Bolt Torque for Polyethylene Flanged Joints.
  - c. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

## 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Catalog information confirming pipe, fittings, and other materials conform to requirements of this section.
    - b. Drawings of specific connection details.
- B. Informational Submittals:
  - 1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
  - 2. Infrared temperature gun product data.
  - 3. Experience, training record, and certificates of persons to be fusing HDPE pipe. Only individuals trained and certified by FS/AWWA (Florida Section of AWWA) on fusion procedures on HDPE shall be approved for installation of electrofusion fittings.
  - 4. Information on manufacturer and model of machine to be used for fusion of HDPE pipe.
  - 5. Testing Plan: Submit at least 15 days prior to testing and include the following as a minimum:
    - a. Testing dates.
    - b. Piping systems and section(s) to be tested.
    - c. Method of isolation.
    - d. Method of conveying water from source to system being tested.
  - 6. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
  - 7. Test report documentation.

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- 8. Installation Plan following the Plastic Pipe Institute, ASTM F2620, and manufacturer's recommendations. Plan shall include, but not be limited to the following major components:
  - a. Pipe and fitting storage.
  - b. Pipe and fitting handling equipment.
  - c. Proposed means to maintain required temperatures for fusing.
  - d. Proposed means to shield fusing area from wind, snow, blowing dust, and rain.
  - e. Proposed means to maintain uniform pipe wall temperature prior to fusing.
  - f. Temperature Control Plan: Plan shall include means to reduce temperature of pipe to limit stated in Part 3 of this Specification.
- 9. Fusion parameters including recommended limits of criteria recorded by data logger
- 10. Fusion report for each joint, including information listed under Article Field Quality Control. Submit daily joint reports within 24 hours after fusion.
- Confirmation that thickness and design of stiffening inserts have been approved by pipe manufacturer and are suitable for use with pipe. Stiffener shall not buckle under a minimum interior pipe temperature of XX degrees F when pipe is empty.

## 1.03 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Pipe Manufacturer: Listed with Plastic Pipe Institute.
  - 2. Experienced in fabricating pipe of similar diameters and wall thickness required for the Work.
  - 3. Persons fusing HDPE pipe shall have a current operator qualification training certificate and wallet card showing operator is qualified to operate machine to be used on the Project and be certified by FS/AWWA (Florida Section of AWWA) on fusion procedures on HDPE shall be approved for installation of electrofusion fittings.

### 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Shipping: Do not cut, kink, or otherwise damage pipe during transportation.
- B. Storage and Handling:
  - 1. Pipe interiors are to be inspected and all debris removed prior to storage.
  - 2. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.
  - 3. Do not exceed the stacking heights stated in AWWA Manual M55.

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- 4. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
- 5. Comply with the requirements of the approved Installation Plan.
- 6. Keep pipe shaded from direct sunlight prior to fusion and installation in trench.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Pipe and Fittings:
  - 1. Conform to requirements of AWWA C906 and ASTM D3261.
  - 2. In compliance with NSF 61.
  - 3. Resin:
    - Potable Water Transmission and Distribution Systems: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 4710 material with cell classification of 445474C, or better. PE 4710 HDPE pipe and fittings shall be manufactured from bimodal resins. Pressure rating shall be based on hydrostatic design stress of 100psi at 73.4 degrees F.
  - 4. Pressure Rating: 100 psi and nominal DR of 21.
  - 5. Outside Diameter Basis: DIPS.
  - 6. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.
  - 7. Fittings:
    - a. Polyethylene fittings shall have same or higher pressure rating as pipe.
    - b. Sizes 12 Inches and Smaller: Molded and manufactured to requirements of ASTM D3261.
    - c. Sizes Larger than 12 Inches: Thermal butt-fused or electrofusion fabricated.
- B. Backup Rings:
  - 1. Convoluted for Flanged Connections:
    - a. ASTM A536, ductile iron.
    - b. Complete with one-piece, molded polyethylene flange adapters.
    - c. Flanged Connections: Same or greater pressure rating as pipe.
  - 2. Ductile Iron: shop-coated inside and out in accordance with AWWA C116.
  - 3. Gaskets: Material, size, and thickness shall be as recommended by gasket manufacturer and in accordance with PPI Technical Note 38. Gasket manufacturer shall provide a table with recommended bolt torque and tightening pattern.

- C. Joints: Thermal butt-fusion or electrofusion. All electrofusion joint fittings shall have ISO 9001 certification and shall be Central Plastics fittings. All butt heat fusion joint fittings shall conform to AWWA C906 and ASTM D 3261, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly. Use appropriate transition fitting or adapter for all joints that are not thermal butt-fused or electro-fused.
- D. Bolts, Nuts, and Washers:
  - 1. Bolt Materials:
    - a. Above grade: Type 316 stainless steel, ASTM A193/A193M, Grade B8M hex head, carbide solution treated and strained.
    - b. Buried pipe: ASTM A307, Grade B carbon steel heavy hex head or stud bolts.
  - 2. Bolt Fabrication: In accordance with ASME B18.2.1.
  - 3. Nut Materials:
    - a. Above Grade Pipe: Type 316 stainless steel, ASTM A194/A194M, Grade 8 hex-head
    - b. Buried Pipe: ASTM A563, Grade A carbon steel heavy hex head nuts
  - 4. Nut Fabrication: In accordance with ASME B18.2.2.
  - 5. Washers:
    - a. Above Grade Pipe: Type 316 stainless steel. Same material as bolts in accordance with ASME B18.21.1.
    - b. Buried Pipe: ASTM F436 hardened steel washers at nuts and bolt heads.
  - 6. Thread Lubricant: Provide bolt manufacturer's recommended lubricant on bolt threads, nuts, nut face, and around bolt hole.
  - 7. Corrosion Resistance: When used in submerged brine water applications, bolts, nuts, and washers shall be coated in polytetrafluoroethylene (PTFE) applied by fastener manufacturer.
- E. Stiffening Inserts:
  - 1. Stiffening inserts used to provide circumferential inside support of HDPE pipe ends shall be constructed of Type 316 stainless steel per ASTM A240.
  - 2. Thickness of metal stiffening inserts shall be as approved by pipe manufacturer and coupling manufacturer for the specific use.
- F. Electrofusion Flex Restraint:
  - 1. Material: HDPE.
  - 2. Method of Attachment: Electrofusion.
  - 3. Designed for restraining movement of HDPE pipe.

- 4. Manufacturers:
  - a. Central Plastics Company.
  - b. Industrial Pipe Fittings, IPF-Plasson.
- G. Electrofusion Couplings:
  - 1. Material: HDPE.
  - 2. Method of Attachment: Electrofusion.
  - 3. Designed for coupling HDPE pipe.
  - 4. Manufacturers:
    - a. Central Plastics Company.
    - b. ISCO Industries.
- H. Concrete Thrust Blocks: See Section 33 05 01, Conveyance Piping—General.
- I. Products that restrain HDPE pipe with wedges or clamps are not acceptable.

## PART 3 EXECUTION

- 3.01 INSTALLATION
  - A. General:
    - 1. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer's recommendations.
    - 2. Follow all requirements of approved Installation Plan where HDPE is to be installed in ambient temperatures less than 50 degrees F, in hot conditions or in windy conditions.
  - B. Joining: Butt-fuse pipes and fittings in accordance with pipe manufacturer's recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavated trench.
    - 1. Remove and extract internal fusion bead from pipe.
      - a. Verify complete internal fusion bead removal was performed. Accomplish by examination of extracted internal fusion bead or by means of closed-circuit television (CCTV) examination.
      - b. Extracted Internal Fusion Bead:
        - 1) Appearance shall have same double roll back semblance as external fusion bead.
        - Possess smooth root cut or pipe smoothness and shall be verified by means of closed-circuit television (CCTV) examination.
      - c. Removal of internal bead may include pipe wall mass. However, wall mass that is removed shall not exceed 1/10th of pipe wall thickness.

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- 2. If HDPE pipe surface temperature is above 100 degrees F as measured with infrared temperature gun, allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.
- 3. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:
  - a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange "stub ends" are not allowed.
  - b. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard.
  - c. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torquing.
- 4. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.
- 5. Minimum Long-Term Field Bending Radius: Restricted to limits recommended by AWWA M55, Table 8-2.
- C. Placement in Trench:
  - 1. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.
  - 2. Position slings for handling pipeline away from butt-fused joints.
  - 3. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.
  - 4. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.
  - 5. Buried Pipe: Snake pipe from one side of trench to other to allow for thermal and settling movements, and as recommended by pipe manufacturer
  - 6. At flanges, valves, and connections, excavate out trench bottom sufficiently to ensure clearance between undisturbed trench bottom and flange, valve, or connection.

# 3.02 FIELD QUALITY CONTROL

- A. Joint Butt Fusion:
  - 1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine. Data to be logged shall include the following and shall be capable of being retrieved electronically:
    - a. Pipe size, dimensions, and wall thickness.
    - b. Machine model and size.

- c. Operator identification.
- d. Job identification number.
- e. Weld number.
- f. Fusion, heating, and drag pressure settings.
- g. Heater plate temperature.
- h. Time stamp showing when weld was performed.
- i. Heating and curing time of weld.
- j. Curing temperature readings and time stamps of readings.
- k. Error messages and warnings for out of range temperature or pressure settings.
- 2. In addition to logged items above, the following shall be logged or annotated on report:
  - a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.
  - b. Ambient temperature, wind speed, precipitation, and humidity.
  - c. If internal bead was removed.
  - d. Environmental actions taken (such as, use of tarps, enclosures, and blankets).
  - e. Type of HDPE and manufacturer.
- B. Joint Weld Inspection:
  - 1. Visually examine each joint in accordance with the guidelines in ASTM F2620. Remove and replace any joints not meeting the standard.
  - 2. Mechanical Joint Testing:
    - a. Pipe Wall Thickness 1-Inch or Less: Test joints in accordance with bend back testing provided in Appendix X4 of ASTM F2620.
    - b. Pipe Wall Thickness Greater than 1-Inch: Test joints in accordance with the guided side bend testing in accordance with ASME BPVC, Section IX, Article XXI-XXIV.
    - c. Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with Work.
    - d. Test Frequency: First joints selected at random by Engineer.
- C. Pipeline Hydrostatic Test: Testing to be performed in accordance with Section 40 80 01, Process Piping Leakage Testing.

## 3.03 DISINFECTION

- A. Conform to the requirements of Section 33 13 00, Disinfection of Water Utility Distribution Facilities.
- B. Active chlorine concentration shall not exceed 10 percent.

## 3.04 MANUFACTURER'S SERVICES

A. Provide pipe manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for assistance during pipe joining operations and pipe installation.

## **END OF SECTION**

## SECTION 33 13 00 DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

## PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Water Works Association (AWWA):
    - a. B300, Hypochlorites.
    - b. B301, Liquid Chlorine.
    - c. B302, Ammonium Sulfate.
    - d. B303, Sodium Chlorite.
    - e. C651, Disinfecting Water Mains.
    - f. C652, Disinfection of Water Storage Facilities.
    - g. C653, Disinfection of Water Treatment Plants.
  - 2. NSF International (NSF):
    - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
    - b. NSF/ANSI 372, Drinking Water System Components Lead Content.
  - 3. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

### 1.02 SUBMITTALS

- A. Informational Submittals:
  - 1. Plan describing and illustrating conformance to appropriate AWWA standards and this Specification.
  - 2. Procedure and plan for cleaning system.
  - 3. Procedures and plans for disinfection and testing.
  - 4. Proposed locations within system where Samples will be taken.
  - 5. Type of disinfecting solution and method of preparation.
  - 6. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
  - 7. Method of disposal for highly chlorinated disinfecting water.
  - 8. Independent Testing Agency: Certification that testing agency is qualified to perform chlorine concentration testing and bacteriological testing in accordance with AWWA standards, agency requirements, and this Specification.

- 9. Certified Bacteriological Test Results:
  - a. Facility tested is free from coliform bacteria contamination.
  - b. Forward results directly to Owner.

### 1.03 QUALITY ASSURANCE

A. Independent Testing Agency: Certified in the State of Florida with 10 years' experience in field of water sampling and testing. Agency shall use calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

### 1.04 SEQUENCING

- A. Commence disinfection after completion of following:
  - 1. Completion and acceptance of internal painting of system(s).
  - 2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.
  - 3. Disinfection of:
    - a. Pumps and associated system piping.
    - b. Filter vessels, including underdrains. This disinfection will take place prior to GAC addition to the filter vessels.
    - c. Treatment plant basins and processes used to supply water to system.
    - d. Approval of disinfection plan.

# PART 2 PRODUCTS

- 2.01 GENERAL
  - A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
    - 1. Use or reuse of components and materials without a traceable certification is prohibited.

### 2.02 WATER FOR DISINFECTION AND TESTING

- A. Clean, uncontaminated, and potable.
- B. Make arrangements for water supply and convey water in disinfected pipelines or containers.

DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES 33 13 00 - 2

## 2.03 DISINFECTANT

A. The following disinfectant product(s) shall not be used: Chlorine gas.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Conform to AWWA C651 for pipes and pipelines and C653 for water treatment plants and filters, except as modified in these Specifications.
- B. Contractor's Equipment:
  - 1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
  - 2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.
- C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
  - 1. Pumps.
  - 2. Filters.
  - 3. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
  - 4. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.
- D. Prior to application of disinfectants, clean equipment, valves and pipelines of loose and suspended material.
- E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

## 3.02 TURBIDITY

A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

### SWF BAF IMPROVEMENTS

### 3.03 PIPING, FILTER, VALVES, PLUMBING, AND PIPELINES

### A. Cleaning:

- 1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
- 2. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
- 3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
- 4. Flush pipe through flushing branches and remove branches after flushing is completed.
- 5. Drain pipes after flushing. Still water is not allowed in stainless steel pipes.
- B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.
- 3.04 PUMPS
  - A. Disinfecting Solutions: Minimum free chlorine concentration of 100 ppm.
  - B. Application:
    - 1. Inject disinfecting solution into pump and associated piping and circulate for a minimum 3-hour period of time. At end of 3-hour period, solution shall have a strength of at least 50 ppm free chlorine.
    - 2. Operate valves and pump appurtenances during disinfection to ensure disinfecting solution is dispersed into all parts of pump and lines.
    - 3. If disinfecting solution contained in pump has a residual free chlorine concentration less than 50 ppm after the 3-hour retention period, reclean pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
    - 4. After chlorination, flush water from pump until water through unit is chemically and bacteriologically equal to permanent source of supply.

#### 3.05 FILTERS

- A. Prior to disinfection, remove foreign material from filtration structures. Clean using fire hoses and tools suitable for adequate scrubbing and cleaning. Pump or drain scrub water from structures.
- B. Disinfection Procedure: In accordance with AWWA C653, unless herein modified.

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- C. Disinfect the following components: filters, face piping and underdrain.
- D. Clean other new facilities designed to hold or transport process water prior to disinfection of filter system including piping, lake transfer pump and backwash supply pump

### 3.06 DISPOSAL OF CHLORINATED WATER

- A. Do not allow flow into a waterway without neutralizing disinfectant residual.
- B. See appendix of AWWA C653 for acceptable neutralization methods.

#### 3.07 TESTING

- A. Collection of Samples:
  - 1. Coordinate activities to allow Samples to be taken in accordance with this Specification.
  - 2. Provide valves at sampling points.
  - 3. Provide access to sampling points.
- B. Test Equipment:
  - 1. Clean containers and equipment used in sampling and make sure they are free of contamination.
  - 2. Obtain sampling bottles with instructions for handling from an independent testing laboratory.
- C. Chlorine Concentration Sampling and Analysis: Collect and analyze Samples in accordance with AWWA standards.
- D. After equipment, valves and pipelines have been cleaned, disinfected, and refilled with potable water, an independent laboratory will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies.
  - 1. Collect Samples in accordance with applicable AWWA Standard.
  - 2. Analyze Samples for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.
- E. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

### **END OF SECTION**

## SECTION 40 05 15 PIPING SUPPORT SYSTEMS

# PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
  - 2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
  - 3. ASTM International (ASTM):
    - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    - b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
    - c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 4. International Code Council (ICC):
  - 5. International Building Code (IBC).
  - 6. International Mechanical Code (IMC).
  - 7. Manufacturers' Standardization Society (MSS):
    - a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
    - b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

## 1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

## 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
  - 2. Calculations for each type of pipe support, attachment and anchor.

- 3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
- 4. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- B. Informational Submittals:
  - 1. Maintenance information on piping support system.
  - 2. Shop Drawings and Calculations for piping support systems shall be prepared and sealed by a Registered Professional Engineer in the state where the Work is to be installed.

## 1.04 DESIGN REQUIREMENTS

- A. General:
  - 1. Design, size, and locate piping support systems throughout facility, whether shown or not.
  - 2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
  - 3. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
  - 4. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.
  - 5. The contractor shall design and provide all pipe supports.
- B. Pipe Support Systems:
  - 1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
  - 2. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
    - a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
    - b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.
- C. Vertical Sway Bracing: 10-foot maximum centers or as shown.
- D. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.
# PART 2 PRODUCTS

#### 2.01 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.
- B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.
- C. Materials: Type 316 stainless steel saddles, support pipe/braces with ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads as needed.

### 2.02 HANGERS

- A. Clevis: MSS SP 58, Type 1:
  - 1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
  - 2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
  - 3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.
- B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:
  - 1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
  - 2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.
- C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:
  - 1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
  - 2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.
- D. Pipe Rollers and Supports: MSS SP 58, Type 44:
  - 1. Anvil; Figure 175, sizes 2 inches through 30 inches.
  - 2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

### 2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

- A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):
  - 1. Anvil; Figure 199, 3,000-pound rating.
  - 2. B-Line; Figure B3067, 3,000-pound rating.

- B. Adjustable "J" hanger MSS SP 58, Type 5:
  - 1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
  - 2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.
- C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.
- D. Channel Type:
  - 1. Unistrut.
  - 2. Anvil; Power-Strut.
  - 3. B-Line; Strut System.

# 2.04 PIPE SADDLES

- A. Provide 90-degree to120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.
  - 1. In accordance with Standard Detail 4005-500.
- B. Saddle Supports, Pedestal Type:
  - 1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
  - 2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt.
    - a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
    - b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.
  - 3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
    - a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
    - b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

# 2.05 CHANNEL TYPE SUPPORT SYSTEMS

- A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.
- B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.
- C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

- D. Manufacturers and Products:
  - 1. B-Line; Strut System.
  - 2. Unistrut.
  - 3. Anvil; Power-Strut.
  - 4. Aickinstrut (FRP System).
  - 5. Enduro-Durostrut (FRP Systems).

#### 2.06 PIPE CLAMPS

- A. Riser Clamp: MSS SP 58, Type 8.
  - 1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
  - 2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

### 2.07 ELBOW AND FLANGE SUPPORTS

- A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.
- B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.
- C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

### 2.08 INTERMEDIATE PIPE GUIDES

- A. Type: Hold down pipe guide.
  - 1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.
- B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.
  - 1. Anvil; Figure 137 and Figure 137S.
  - 2. B-Line; Figure B3188 and Figure B3188NS.

#### 2.09 PIPE ALIGNMENT GUIDES

- A. Type: Spider.
- B. Manufacturers and Products:
  - 1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
  - 2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

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# 2.10 PIPE ANCHORS

- A. Type: Anchor chair with U-bolt strap.
- B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

### 2.11 SEISMIC RESTRAINTS

- A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.
- B. Manufacturers:
  - 1. Mason Industries.
  - 2. B-Line.
  - 3. Anvil.

# 2.12 ACCESSORIES

- A. Anchor Bolts:
  - 1. Size and Material: Sized by Contractor for required loads, and as specified in Section 05 50 00, Metal Fabrications.
  - 2. Bolt Length (Extension Above Top of Nut):
    - a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
    - b. Maximum Length: No more than a full nut depth above top of nut.

### B. Dielectric Barriers:

- 1. Plastic coated hangers, isolation cushion, or tape.
- 2. Manufacturer and Products:
  - a. B-Line; B1999 Vibra Cushion.
  - b. B-Line; Iso Pipe, Isolation Tape.
- C. Insulation Shields:
  - 1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
  - 2. Manufacturers and Products:
    - a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
    - b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.
- D. Welding Insulation Saddles:
  - 1. Type: MSS SP 58, Type 39.
  - 2. Manufacturers and Products:
    - a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
    - b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

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- E. Plastic Pipe Support Channel:
  - 1. Type: Continuous support for plastic pipe and to increase support spacing.
  - 2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.
- F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.
- G. Attachments:
  - 1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
  - 2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
  - 3. Welded Beam Attachment: MSS SP 58, Type 22.
    - a. Anvil; Figure 66.
    - b. B-Line; Figure B3083.
  - 4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
  - 5. Concrete Attachment Plates:
    - a. Anvil; Figure 47, Figure 49, or Figure 52.
    - b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

# PART 3 EXECUTION

### 3.01 INSTALLATION

- A. General:
  - 1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
  - 2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
  - 3. Support piping connections to equipment by pipe support and not by equipment.
  - 4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
  - 5. Support no pipe from pipe above it.
  - 6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
  - 7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
  - 8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

- 9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
- 10. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
- 11. Repair mounting surfaces to original condition after attachments are completed.
- B. Standard Pipe Supports:
  - 1. Horizontal Suspended Piping:
    - a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
    - b. Grouped Pipes: Trapeze hanger system.
  - 2. Horizontal Piping Supported from Walls:
    - a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
    - b. Stacked Piping: Wall mounted framing system and "J" hangers acceptable for pipe smaller than 3-inch.
    - c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
  - 3. Horizontal Piping Supported from Floors:
    - a. Saddle Supports:
      - 1) Pedestal Type, elbow and flange.
      - 2) Provide minimum 1-1/2-inch grout beneath baseplate.
    - b. Floor Mounted Channel Supports:
      - 1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
      - Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
      - 3) Attach pipe to channel with clips or pipe clamps.
    - c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.
  - 4. Insulated Pipe:
    - a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
    - b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
    - c. Wall-mounted pipe clips not acceptable for insulated piping.
  - 5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

- C. Standard Attachments:
  - 1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
    - a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
    - b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
  - 2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
    - a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
  - 3. Steel Beams: I-beam clamp or welded attachments.
  - 4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
  - 5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
  - 6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.
- D. Saddles for Steel or Concrete Pipe: Provide 90-degree to120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.
- E. Intermediate and Pipe Alignment Guides:
  - 1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
  - 2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
  - 3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.
- F. Accessories:
  - 1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
  - 2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.

- 3. Dielectric Barrier:
  - a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
  - b. Install rubber wrap between submerged metal pipe and oversized clamps.

# **END OF SECTION**

# SECTION 40 27 00 PROCESS PIPING—GENERAL

# PART 1 GENERAL

## 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:
  - 1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
  - 2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
  - 3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
  - 4. American Society of Mechanical Engineers (ASME):
    - a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
    - b. B1.20.1, Pipe Threads, General Purpose (Inch).
    - c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
    - d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
    - e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
    - f. B16.9, Factory-Made Wrought Buttwelding Fittings.
    - g. B16.11, Forged Fittings, Socket-Welding and Threaded.
    - h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
    - i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
    - j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
    - k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
    - l. B16.25, Buttwelding Ends.
    - m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
    - n. B31.1, Power Piping.
    - o. B31.3, Process Piping.
    - p. B31.9, Building Services Piping.
    - q. B36.10M, Welded and Seamless Wrought Steel Pipe.
  - 5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.

- 6. American Water Works Association (AWWA):
  - a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
  - b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
  - c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
  - d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
  - f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
  - g. C153/A21.53, Ductile-Iron Compact Fittings.
  - h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
  - i. C606, Grooved and Shouldered Joints.
- 7. American Welding Society (AWS):
  - a. Brazing Handbook.
  - b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
  - c. D1.1/D1.1M, Structural Welding Code Steel.
  - d. QC1, Standard for AWS Certification of Welding Inspectors.
- 8. ASTM International (ASTM):
  - a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
  - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
  - d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
  - e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
  - g. A139/A139M, Standard Specification for Electro-Fusion (Arc)– Welded Steel Pipe (NPS 4 Inches and Over).
  - h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
  - j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
  - k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.

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- 1. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
- M. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- n. A197/A197M, Standard Specification for Cupola Malleable Iron.
- o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
- p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- r. A276, Standard Specification for Stainless Steel Bars and Shapes.
- s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
- w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
- x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
- aa. A536, Standard Specification for Ductile Iron Castings.
- bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
- dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
- ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
- ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

- gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- hh. B32, Standard Specification for Solder Metal.
- ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- jj. B61, Standard Specification for Steam or Valve Bronze Castings.
- kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- ll. B75/B75M, Standard Specification for Seamless Copper Tube.
- mm. B88, Standard Specification for Seamless Copper Water Tube.
- nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
- oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
- pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
- qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
- rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
- ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
- tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
- uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
- vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- ww. D1330, Standard Specification for Rubber Sheet Gaskets.
- xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.
- aaa. D2310, Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

- bbb. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- ccc. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- ddd. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- eee. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- ggg. D2996, Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- hhh. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
- iii. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- jjj. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
- kkk. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
- 111. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
- mmm. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
- nnn. F436, Standard Specification for Hardened Steel Washers.
- 000. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- ppp. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- qqq. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- rrr. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- sss. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- ttt. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- 9. FM Global (FM).
- 10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.

- 11. NSF International (NSF):
  - a. ANSI 61: Drinking Water System Components Health Effects.
  - b. ANSI 372: Drinking Water System Components Lead Content.
- 12. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
- 13. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

### 1.02 DEFINITIONS

- A. Submerged or Wetted:
  - 1. Zone below elevation of:
    - a. Top face of channel walls and cover slabs.

### 1.03 DESIGN REQUIREMENTS

- A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:
  - 1. Boiler and Steam Piping: ASME B31.1.
  - 2. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
  - 3. Building Service Piping: ASME B31.9, as applicable.
  - 4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
  - 5. Thrust Restraints:
    - a. Design for test pressure shown in Piping Schedule.
    - b. Allowable Soil Pressure: 1,000 pounds per square foot.
    - c. Low Pressure Pipelines:
      - 1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
      - 2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

### 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Fabricated Piping:
    - a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.

- b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
- 2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
- 3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
- 4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
- 5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
- 6. Pipe Corrosion Protection: Product data.
- 7. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- B. Informational Submittals:
  - 1. Manufacturer's Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements:
    - a. Pipe and fittings.
    - b. Factory applied resins and coatings.
  - 2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 3. Qualifications:
    - a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
    - b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
    - c. Welders:
      - 1) Continuity log for welders and welding operators.
      - 2) Welder qualification test records conducted by Contractor or manufacturer.
  - 4. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
  - 5. Nondestructive inspection and testing procedures.
  - 6. Test logs.
  - 7. Pipe coating applicator certification.
  - 8. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
  - 9. CWI inspection records and NDE test records.

#### SWF BAF IMPROVEMENTS

## 1.05 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Independent Inspection and Testing Agency:
    - a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
    - b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
    - c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
    - d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
    - e. Verification Welding Inspector: AWS QC1 Certified.
  - 2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
  - 3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
  - 4. Contractor's CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.
- B. Quality Assurance: Provide services of independent inspection and testing agency for welding operations.
  - 1. Note, the presence of Owner's Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01 61 00, Common Product Requirements, and:
  - 1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
  - 2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
  - 3. Linings and Coatings: Prevent excessive drying.
  - 4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
  - 5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.
  - 6. Protect stainless steel from ferrous lifting equipment.

# PART 2 PRODUCTS

# 2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
  - 1. Use or reuse of components and materials without a traceable certification is prohibited.

# 2.02 PIPING

- A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement and on Piping Schedule located on the Drawings.
- B. Diameters Shown:
  - 1. Standardized Products: Nominal size.
  - 2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
  - 3. Cement-Lined Steel Pipe: Lining inside diameter.

# 2.03 JOINTS

- A. Flanged Joints:
  - 1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
  - 2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.
- B. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.
- C. Mechanical Joint Anchor Gland Follower:
  - 1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
  - 2. Thrust rated to 250 psi minimum.
  - 3. Rated operating deflection not less than:
    - a. 3 degrees for sizes through 12 inches.
    - b. 2 degrees for sizes 14 inches through 16 inches.

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- c. 1.5 degrees for sizes 18 inches through 24 inches.
- d. 1 degree for sizes 30 inches through 48 inches.
- 4. UL and FM approved.
- D. Flexible Mechanical Compression Joint Coupling:
  - 1. Stainless steel, ASTM A276, Type 305 bands.
  - 2. Manufacturers:
    - a. Pipeline Products Corp.
    - b. Fernco Joint Sealer Co.

#### 2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "orequal" will be allowed.

#### 2.05 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

#### 2.06 THRUST TIES

- A. Steel Pipe: Fabricated lugs and rods in accordance with details shown on the Drawings.
- B. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

#### 2.07 VENT AND DRAIN VALVES

- A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.
- B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

#### 2.08 FABRICATION

- A. Mark each pipe length on outside with the following:
  - 1. Size or diameter and class.
  - 2. Manufacturer's identification and pipe serial number.
  - 3. Location number on laying drawing.
  - 4. Date of manufacture.
- B. Code markings according to approved Shop Drawings.

C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

## 2.09 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

# PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

### 3.02 PREPARATION

- A. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.
- B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.
- C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

### 3.03 WELDING

- A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.
- B. Weld Identification: Keep paper record of which welder welded each joint.
- C. Pipe End Preparation:
  - 1. Machine Shaping: Preferred.
  - 2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
  - 3. Beveled Ends for Butt Welding: ASME B16.25.

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- D. Surfaces:
  - 1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
  - 2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
  - 3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
- E. Alignment and Spacing:
  - 1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
  - 2. Root Opening of Joint: As stated in qualified welding procedure.
  - 3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.
- F. Climatic Conditions:
  - 1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
  - 2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.
- G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.
- H. Surface Defects: Chip or grind out those affecting soundness of weld.
- I. Weld Quality: Meet requirements of governing welding codes.
- 3.04 INSTALLATION—GENERAL
  - A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
  - B. Remove foreign objects prior to assembly and installation.
  - C. Flanged Joints:
    - 1. Install perpendicular to pipe centerline.
    - 2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.

- 3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
- 4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
- 5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
- 6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
- 7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
- 8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
- 9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
- 10. Manufacturer: Same as pipe manufacturer.
- D. Threaded and Coupled Joints:
  - 1. Conform to ASME B1.20.1.
  - 2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
  - 3. Countersink pipe ends, ream and clean chips and burrs after threading.
  - 4. Make connections with not more than three threads exposed.
  - 5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.
- E. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.
- F. PVC and CPVC Piping:
  - 1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
  - 2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
  - 3. Do not thread Schedule 40 pipe.
- G. Ductile Iron Piping:
  - 1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
  - 2. Dressing Cut Ends:
    - a. General: As required for the type of joint to be made.
    - b. Rubber Gasketed Joints: Remove sharp edges or projections.
    - c. Push-On Joints: Bevel, as recommended by pipe manufacturer.

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- d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.
- H. High-Density Polyethylene Piping: In accordance with Section 33 05 01, High-Density Polyethylene Pressure pipe.

### 3.05 INSTALLATION—EXPOSED PIPING

- A. Piping Runs:
  - 1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
  - 2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.
- B. Supports: As specified in Section 40 05 15, Piping Support Systems.
- C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.
- D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.
- E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.
- F. Piping clearance, unless otherwise shown:
  - 1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
  - 2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
  - 3. From Adjacent Work: Minimum 6 inch(es) from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
  - 4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

- 5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
- 6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
- 7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

# 3.06 INSTALLATION—BURIED PIPE

- A. Joints:
  - 1. Dissimilar Buried Pipes:
    - a. Provide flexible mechanical compression joints for pressure pipe.

## B. Placement:

- 1. Keep trench dry until pipe laying and joining are completed.
- 2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
- 3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
- 4. Measure for grade at pipe invert, not at top of pipe.
- 5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
- 6. Prevent foreign material from entering pipe during placement.
- 7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
- 8. Lay pipe upgrade with bell ends pointing in direction of laying.
- 9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
- 10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
  - a. Shorter pipe lengths.
  - b. Special mitered joints.
  - c. Standard or special fabricated bends.
- 11. After joint has been made, check pipe alignment and grade.
- 12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
- 13. Prevent uplift and floating of pipe prior to backfilling.

- C. PVC, CPVC, or HDPE Pipe Placement:
  - 1. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
  - 2. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
  - 3. Shield ends to be joined from direct sunlight prior to and during the laying operation.
- D. Tolerances:
  - 1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2 inches.
  - 2. Deflection From Vertical Grade: Maximum 1/4 inch(es).
  - 3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
  - 4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
  - 5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

## 3.07 INSTALLATION—CONCRETE ENCASED

- A. Provide reinforced concrete pipe encasement where shown on the Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on the Drawings for encasement requirements.
- B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

### 3.08 PIPE CORROSION PROTECTION

- A. Ductile Iron Pipe:
  - 1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
  - 2. Buried: Wrap with polyethylene bagging.
  - 3. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.
- B. As specified in Section 09 90 00, Painting and Coating.

- C. Piping Accessories:
  - 1. Exposed:
    - a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
    - b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
  - 2. Buried:
    - a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
    - b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
    - c. Flexible Couplings and Similar Items: Wrap with heat shrink wrap or coat with cement.
    - d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
    - e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.
- D. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.
- E. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

# 3.09 THRUST RESTRAINT

- A. Location:
  - 1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
  - 2. Exposed Piping: At all joints in piping.
- B. Thrust Ties:
  - 1. Steel Pipe: Attach with joint harness specified in Section 40 27 01, Process Piping Specialties.
  - 2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
  - 3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

### 3.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

### 3.11 BRANCH CONNECTIONS

- A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.
- B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.
- C. Threaded Pipe Tap Connections:
  - 1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
  - 2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
  - 3. Limitations: Threaded taps in pipe barrel are unacceptable.

### 3.12 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines as shown.

### 3.13 DISINFECTION

A. See Section 33 13 00, Disinfecting of Water Utility Distribution.

#### 3.14 FIELD FINISHING

- A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.
- B. As specified in Section 09 90 00, Painting and Coating.
- 3.15 PIPE IDENTIFICATION
  - A. As specified in Section 09 90 00, Painting and Coating.

PROCESS PIPING—GENERAL 40 27 00 - 18

# 3.16 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.
- B. Minimum Duties of Welding Inspector:
  - 1. Job material verification and storage.
  - 2. Qualification of welders.
  - 3. Certify conformance with approved welding procedures.
  - 4. Maintenance of records and preparation of reports in a timely manner.
  - 5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.
- C. Required Weld Examinations:
  - 1. Perform examinations in accordance with Piping Code, ASME B31.1, except that 5 percent of circumferential butt welds shall be random radiographed.
  - 2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
  - 3. Examine at least one of each type and position of weld made by each welder or welding operator.
  - 4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

# 3.17 CLEANING

- A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.
- B. Blow clean of loose debris plant process air, dry chlorine gas or liquid, and instrument air lines with compressed air at 4,000 fpm; do not flush with water.
- C. Immediately after cleaning dry chlorine gas or liquid, and service piping, dry to minus 40 degrees F dew point with dry compressed instrument air or compressed commercial grade nitrogen.
- D. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

- E. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- F. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

# 3.18 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification:
  - 1. Piping Schedule Legend.
  - 2. Piping Schedule.
  - 3. Data Sheets.

Number	Title
33 05 01.10	High-Density Polyethylene (HDPE) Pressure Pipe and Fittings
40 27 00.01	Cement-Mortar-Lined Ductile Iron Pipe and Fittings
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings

# **END OF SECTION**

# PIPING SCHEDULE LEGEND

# **SERVICE**

ALP	Air-Low Pressure		
BWD	Backwash Drain		
BWD/FI/D	Backwash Drain and Filtrate Drain		
BWS	Backwash Supply		
DR	Drain		
FI	Filtrate		
FI/BWS	Filtrate and Backwash Supply		
FI/D	Filtrate Drain		
FI/RW	Filtrate and Raw Water		
RW	Raw Water		
V	Vents		
W	Waste		

# **EXPOSURE**

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged

ENC Concrete Encased

# **MATERIAL**

- CLDI Cement-Lined Ductile Iron
- HDPE High-Density Polyethylene

PVC Polyvinyl Chloride

SST Stainless Steel

## SWF BAF IMPROVEMENTS

# JOINT TYPE

- FL Flanged
- GR Grooved
- PRJ Proprietary Restrained

W Welded (including solvent and fusion)

# PRESSURE TEST

- G Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
- H Hydrostatic
- NA Not Applicable

Piping Schedule							
Service	Legend	Size(s) (In.) <sup>1</sup>	Exposure	Piping Material	Specification Section	Test Pressure and Type (psig-x), x = Type indicated in Legend	Remarks
Air Low Pressure	ALP	All	EXP	316 SST	40 27 00.08	37.5P	
Backwash Drain	BWD	All	EXP/BUR	CLDI	40 27 00.01	G	Gravity Services
Backwash Drain and Filtrate Drain	BWD/FI/W	All	EXP/BUR	CLDI	40 27 00.01	G	Gravity Services
Backwash Supply	BWS	All	EXP/BUR	CLDI	40 27 00.01	40H	
Drain	D	All	EXP/BUR	PVC – DWG	40 27 00.10	G	Gravity Services
Filtrate	FI	All	EXP/	CLDI	40 27 00.01	15H	
Filtrate and Backwash Supply	FI/BWS	All	EXP	CLDI	40 27 00.01	40H	
Filtrate Drain	FI/D	All	EXP	CLDI	40 27 00.01	G	Gravity Services
			BUR	HDPE	33 05 01.10	47.5H	
Raw Water	RW	All	EXP	CLDI	40 27 00.01	47.5H	
			BUR	HDPE	33 05 01.10	47.5H	
Raw Water and Backwash Drain	RW/BWD	All	EXP	CLDI	40 27 00.01	47.5H	
Vent	V	<=4	EXP/BUR	PVC SCH80	40 27 00.10	N/A	Gravity Services
<sup>1</sup> ">" Greater Than "<" Less Than							

"<=" Less Than or Equal To ">=" Greater Than or Equal To

"All" All Sizes

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS				
Item	Description			
General	Materials in contact with potable water shall conform to NSF 61 acceptance.			
	Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).			
Pipe	Buried Liquid Service Using Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron.			
	Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.			
Lining	Cement-mortar: AWWA C104/A21.4.			
Fittings	Lined and coated with fusion bonded ep006Fy coating in accordance with AWWA standard C116. All fittings shall conform to the requirements of AWWA/ANSI C110/21.10			
	Mechanical: AWWA/ANSI C110/21.11 and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure.			
	Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, and ANSI A21.10 ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125			
	flat face. Gray cast iron will not be allowed.			

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS			
Item	Description		
Joints	Mechanical: 250 psi minimum working pressure		
	Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex.		
	Flange: Dimensions per AWWA C110/A21.10 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.		
	Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.		
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard.		
	Buried: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.		
	Exposed: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 to 60 percent of bolt minimum yield stress.		
Gaskets	General: Gaskets in contact with potable water shall be NSF ANSI 61 certified.		
	Mechanical and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11.		
	Flanged, Water, Sewage and Hot Air Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000.		
	Full face for flat-faced flanges, flat-ring type for raised-face flanges. Blind flanges shall be epoxy-lined in accordance with the system specified above.		
	Gasket pressure rating to equal or exceed the system hydrostatic test pressure.		
Joint Lubricant	Manufacturer's standard.		

# **END OF SECTION**

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE				
Item	Size	Description		
Pipe	3" thru 6"& larger	Schedule 10S: ASTM A312/A312M, Type 316L, pickled and passivated.		
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.		
	2" & larger	Butt-welded or flanged at valves and equipment.		
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F316 or cast Class 150, ASTM A351/A351M, Grade CF8M/316.		
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.		
	3" & larger	Butt-Welded: ASTM A403/A403M, Grade WP316L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.		
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.		
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.		
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside.		
		ASTM A240/A240M Type 316L "as-welded grade", conforming to MSS SP 43, wall thickness same as pipe.		

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE				
Item	Size	Description		
		Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.		
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.		
Bolting	All	Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.		
Gaskets	All Flanges	<ul> <li>Flanged, Water, Hot Air, Fuel Gas and Sewage Services: 1/8 inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade.</li> <li>Blind Flanges: Gasketed covering entire inside face with gasket cemented to blind flange</li> </ul>		
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape.		
		Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.		

# **END OF SECTION**

STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE 40 27 00.08 DATA SHEET - 2
SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS							
Item	Size	Description					
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.					
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection.					
		Threaded Nipples: Schedule 80 PVC.					
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.					
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.					
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling					
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.					
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber.					
		Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.					

<b>SECTION 40 27 00.10</b>
POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

Item	Size	Description						
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724 or approved equal. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.						
Thread Lubricant	All	Teflon Tape.						

**END OF SECTION** 

POLYVINYL CHLORIDE(PVC) PIPE AND FITTINGS 40 27 00.10 DATA SHEET - 2

### SECTION 40 27 01 PROCESS PIPING SPECIALTIES

# PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Society of Mechanical Engineers (ASME):
    - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
    - b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
  - 2. American Water Works Association (AWWA):
    - a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
    - b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
    - c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
    - d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
    - e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
    - f. Manual M11, Steel Pipe—A Guide for Design and Installation.
  - 3. ASTM International (ASTM):
    - a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
  - 4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
  - 5. NSF International (NSF):
    - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
    - b. NSF/ANSI 372, Drinking Water System Components Lead Content.

# 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
  - 2. Metal Bellows Field Finishing:
    - a. Manufacturer's recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.
    - b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.

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- c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09 90 00, Painting and Coating.
- 3. Chemical Injectors:
  - a. Type, size, quantity, materials, and model number of each.
  - b. Sketch of each showing major parts, main pipe, and dimensions.
  - c. Details and model number of each support system and component.
  - d. Details and model of connects (for example, service saddle, weld-o-let).
- B. Informational Submittals:
  - 1. Coupling Harness:
    - a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
    - b. Weld procedure qualifications.
    - c. Load proof-testing report of prototype restraint for any size coupling.
  - 2. Basket Strainer:
    - a. Manufacturer's written/printed installation instructions.
    - b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
- C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

# PART 2 PRODUCTS

- 2.01 GENERAL
  - A. Provide required piping specialty items, whether shown or not shown on the Drawings, as required by applicable codes and standard industry practice.
  - B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.
  - C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
    - 1. Use or reuse of components and materials without a traceable certification is prohibited.

# 2.02 CONNECTORS

- A. Elastomer Bellows Connector:
  - 1. Type: Fabricated spool, with single filled arch.
  - 2. Materials: Nitrile tube and wrap-applied neoprene cover.
  - 3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.
  - 4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
  - 5. Thrust Restraint: Control rods to limit travel of elongation and compression.
  - 6. Manufacturers and Products:
    - a. Goodall Rubber Co.; Specification E-1462.
    - b. Garlock; Style 204.
    - c. Unisource Manufacturing, Inc.; Style 1501.
    - d. Proco Products, Inc.; Series 220.
- B. Metal Bellows Connector:
  - 1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
  - 2. Material: Type 316 stainless steel.
  - 3. End Connections: ANSI 150-pound carbon steel flanges.
  - 4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
  - 5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
  - 6. Manufacturers and Products:
    - a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
    - b. Metraflex; Model MN.
    - c. Senior Flexonics Pathway, Inc.; Expansion Joints.

# 2.03 COUPLINGS

- A. General:
  - 1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
  - 2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
  - 3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
  - 4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on the Drawings.

- 5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.
- B. Flanged Coupling Adapter:
  - 1. Anchor studs where required for thrust restraint.
  - 2. Manufacturers and Products:
    - a. Steel Pipe:
      - 1) Dresser Piping Specialties; Style 128.
      - 2) Smith-Blair, Inc.; Style 913.
    - b. Ductile Iron Pipe:
      - 1) Dresser Piping Specialties; Style 128.
      - 2) Smith-Blair, Inc.; Style 912.
- C. Restrained Flange Adapter:
  - 1. Pressure Rating:
    - a. Minimum Working Pressure Rating: Not less than 150 psi.
    - b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
  - 2. Thrust Restraint:
    - a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
    - b. Products employing set screws that bear directly on pipe will not be acceptable.
  - 3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.
- D. HDPE Transition Adapter:
  - 1. Adapters designed for transitions between HDPE and ductile iron pipe size (DIPS pipe and fittings shall meet the following requirements:
    - a. Adapter Design: Design to adapter between HDPE fusion end style joint connection and ductile iron pipe mechanical joining connections of ductile iron and stainless steel flange end connections. Adapter SDR to match SDR of mating pipe. Adapter joint to be fully restrained for the test pressure specified in Piping Schedule of Section 40 27 02, Process Piping—General.
    - b. Testing certifications: Adapters certified by manufacturer to meet:
      - 1) Hydraulic Burst Pressure Test per ASTM D1599.
      - 2) Sustained Pressure Test per ASTM D1598 for 134 psi (170 hours minimum).
      - 3) Cyclic Pressure Test from 0 to 240 psi (3 million cycles).

- 2. Type 316 stainless steel bolts, nuts and washer accessories.
- 3. Adapter shall be manufactured by Performance Piping Inc. "or-equal".

# 2.04 EXPANSION JOINTS

- A. Metal Bellows:
  - 1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
  - 2. Material: Type 316 stainless steel.
  - 3. End Connections: ASME 150-pound carbon steel flanges.
  - 4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
  - 5. Length: Minimum of eight convolutions and minimum axial compression of 2 inches.
  - 6. Manufacturers and Products:
    - a. Metraflex, Model MN.
    - b. Senior Flexonics Pathway, Inc.; Expansion Joints.

# 2.05 FLEXIBLE EXPANSION JOINTS

- A. Design:
  - 1. Ball and socket type for earth settlement compensation.
  - 2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
  - 3. Assembly shall accommodate up to 4 inches of expansion in length.
  - 4. Ductile iron conforming to AWWA C153/A21.53.
  - 5. Rated for 350 psi.
  - 6. Components shall be lined and coated by manufacturer with fusionbonded epoxy on all surfaces not bearing gaskets.
  - 7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
  - 8. Joint connecting to mechanical joint shall be thrust restrained.
  - 9. Bonding:
    - a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
    - b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
    - c. Bond wires shall be 2 AWG with two 12-inch-long THHN insulated 12 AWG wire pigtails.
- B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend.

#### SWF BAF IMPROVEMENTS

#### 2.06 SERVICE SADDLES

- A. Double-Strap Iron:
  - 1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
  - 2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
  - 3. Taps: Iron pipe threads.
  - 4. Materials:
    - a. Body: Malleable or ductile iron.
    - b. Straps: Galvanized steel.
    - c. Hex Nuts and Washers: Steel.
    - d. Seal: Rubber.
  - 5. Manufacturers and Products:
    - a. Smith-Blair; Series 313 or 366.
    - b. Dresser; Style 91.

#### 2.07 OUTLET/TAPPING SADDLES

- A. Materials:
  - 1. Straps: Alloy steel with 3/4-inch threaded ends.
  - 2. Seal: O-Ring SBR rubber gasket.
  - 3. Compatible with ductile iron pipe.
- B. Connection: AWWA C110/A21.10 flange.
- C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.
- D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

#### 2.08 PIPE SLEEVES

- A. Steel Pipe Sleeve:
  - 1. Minimum Thickness: 3/16 inch.
  - 2. Seep Ring:
    - a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
    - b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
    - c. Continuously fillet weld on each side all around.

- 3. Factory Finish:
  - a. Galvanizing:
    - 1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
    - 2) Electroplated zinc or cadmium plating is unacceptable.
  - b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.
- B. Modular Mechanical Seal:
  - 1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
  - 2. Fabrication:
    - a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
    - b. Pressure plates shall be reinforced nylon polymer.
  - 3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
  - 4. Manufacturer: Thunderline Corp., Link-Seal Division.

### 2.09 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

- A. Ductile Iron Wall Pipe:
  - 1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
  - 2. Thickness: Equal to or greater than remainder of pipe in line.
  - 3. Fittings: In accordance with applicable Pipe Data Sheet.
  - 4. Thrust Collars:
    - a. Rated for thrust load developed at 250 psi.
    - b. Safety Factor: 2, minimum.
    - c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
  - 5. Manufacturers:
    - a. American Cast Iron Pipe Co.
    - b. U.S. Pipe and Foundry Co.

# PART 3 EXECUTION

- 3.01 GENERAL
  - A. Provide accessibility to piping specialties for control and maintenance.

#### SWF BAF IMPROVEMENTS

#### 3.02 PIPING FLEXIBILITY PROVISIONS

#### A. General:

- 1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
- 2. Install flexible couplings to facilitate piping installation, in accordance with approved Shop Drawings.
- B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.
- C. Flexible Joints at Concrete Structures: Install 18 inches or less from face of structures; joint may be flush with face.

#### 3.03 PIPING TRANSITION

- A. Applications:
  - 1. Provide complete closure assembly where pipes meet other pipes or structures.
  - 2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
  - 3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown.
  - 4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
  - 5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
  - 6. Elastomer sleeves bonded to pipe ends are not acceptable.
- B. Installation:
  - 1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
  - 2. Concrete Closures:
    - a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
    - b. Clean pipe surface before placing closure collars.
    - c. Wet nonmetallic pipe thoroughly prior to pouring collars.
    - d. Prevent concrete from entering pipe.
    - e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.

- f. Make entire collar in one placement.
- g. After concrete has reached initial set, cure by covering with well-moistened earth.

#### 3.04 PIPING EXPANSION

- A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.
- B. Expansion Joints:
  - 1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
  - 2. Nonmetallic Pipe: Teflon bellows expansion joint.
  - 3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
  - 4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
  - 5. Pipe Run Offset: Flexible metal hose.
- C. Anchors and Anchor Walls: Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

#### 3.05 SERVICE SADDLES

- A. Ferrous Metal Piping (except stainless steel): Double-strap iron.
- B. Plastic Piping: Nylon-coated iron.
- 3.06 OUTLET/TAPPING SADDLE
  - A. Install in accordance with manufacturer's written instructions.

#### 3.07 COUPLINGS

- A. General:
  - 1. Install in accordance with manufacturer's written instructions.
  - 2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
  - 3. Do not remove pipe coating. If damaged, repair before joint is made.
  - 4. Application:
    - a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
    - b. Concrete Encased Couplings: Flexible coupling.

#### SWF BAF IMPROVEMENTS

#### 3.08 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

- A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.
- B. Product Applications Unless Shown Otherwise:
  - 1. Nonmetallic Piping: Teflon bellows connector.
  - 2. Copper Piping: Flexible metal hose connector.
  - 3. Compressor and Blower Discharge: Metal bellows connector.
  - 4. All Other Piping: Elastomer bellows connector.
- C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

#### 3.09 PIPE SLEEVES

- A. Application:
  - 1. As specified in Section 40 27 00, Process Piping—General.
  - 2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
  - 3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
  - 4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.
- B. Installation:
  - 1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
  - 2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

#### 3.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

- A. Applications:
  - 1. Watertight and Below Ground Penetrations:
    - a. Wall pipes with thrust collars.
    - b. Provide taps for stud bolts in flanges to be set flush with wall face.
  - 2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
  - 3. Existing Walls: Rotary drilled holes.
  - 4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

- B. Wall Pipe Installation:
  - 1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.
  - 2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

# **END OF SECTION**

## SECTION 40 27 02 PROCESS VALVES AND OPERATORS

# PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
  - 2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
  - 3. American Society of Mechanical Engineers (ASME):
    - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
    - b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
  - 4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
  - 5. American Water Works Association (AWWA):
    - a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
    - b. C500, Metal-Seated Gate Valves for Water Supply Service.
    - c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
    - d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
    - e. C509, Resilient-Seated Gate Valves for Water Supply Service.
    - f. C510, Double Check Valve Backflow Prevention Assembly.
    - g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
    - h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
    - i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
    - j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
    - k. C542, Electric Motor Actuators for Valves and Slide Gates.
    - 1. C550, Protective Interior Coatings for Valves and Hydrants.
    - m. C606, Grooved and Shouldered Joints.
    - n. C800, Underground Service Line Valves and Fittings.

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- 6. ASTM International (ASTM):
  - a. A276, Standard Specification for Stainless Steel Bars and Shapes.
  - b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
  - c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
  - d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
  - e. B61, Standard Specification for Steam or Valve Bronze Castings.
  - f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
  - h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
  - i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
  - j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
  - k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
  - 1. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
  - m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
  - n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- 7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
- 8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
- 9. FM Global (FM).
- 10. Food and Drug Administration (FDA).
- 11. International Association of Plumbing and Mechanical Officials (IAPMO).
- 12. Manufacturers Standardization Society (MSS):
  - a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
  - b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
  - c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
  - d. SP-88, Diaphragm Valves.
  - e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

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- 13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
- 14. NSF International (NSF):
  - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
  - b. NSF/ANSI 372, Drinking Water System Components Lead Content.
- 15. UL.
- 16. USC Foundation for Cross-Connection Control and Hydraulic Research.

# 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
    - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
    - c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
    - d. Power and control wiring diagrams, including terminals and numbers.
    - e. For each power actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.
    - f. Sizing calculations for open-close/throttle and modulating valves.
    - g. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
    - a. Electric actuators; full compliance with AWWA C542.
    - b. Butterfly valves; full compliance with AWWA C504.
  - 3. Tests and inspection data.
  - 4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
  - 5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

#### SWF BAF IMPROVEMENTS

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.
- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- C. Valve same size as adjoining pipe, unless otherwise called out on the Drawings or in Supplements.
- D. Valve ends to suit adjacent piping.
- E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.
- F. Size operators and actuators to operate valve for full range of pressures and velocities.
- G. Valve to open by turning counterclockwise, unless otherwise specified.
- H. Factory mount operator, actuator, and accessories.
- I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
  - 1. Use or reuse of components and materials without a traceable certification is prohibited.

#### 2.02 SCHEDULE

A. Additional requirements relative to this section are shown on Electric Actuated Valve Schedule and Self-Regulated Valve Schedule located at the end of this section.

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# 2.03 MATERIALS

- A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
  - Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
  - 2. Stainless steel Alloy 18-8 may be substituted for bronze.
- B. Valve materials in contact with or intended for drinking water service to meet the following requirements:
  - 1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
  - 2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.
  - 3. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

# 2.04 FACTORY FINISHING

- A. General:
  - 1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
  - 2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
  - 3. Material in contact with potable water shall conform to NSF/ANSI 61.
  - 4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be "safety yellow."
- B. Where epoxy lining and coating are specified, factory finishing shall be as follows:
  - 1. In accordance with AWWA C550.
  - 2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.
  - 3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

- 2.05 VALVES
  - A. Ball Valves: Gate Valves:
    - 1. Type V135 resilient wedge, ductile iron gate valve 3 inches to 36 inches
      - Ductile iron body, resilient wedge, bronze stem and stem nut, mechanical joint ends, non-rising stem, in accordance with AWWA C515, minimum design working water pressure 250 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
      - b. Manufacturers
        - 1) Clow: Model 2638.
        - 2) M&H: Style 7000 and C515.
        - 3) Mueller: A-2361 RWGV MJXMJ.
  - B. Ball Valves:
    - 1. Type V306 Stainless Steel Ball Valve 2 Inches and Smaller:
      - a. Two-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, NPT threaded ends, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000 psig CWP, complies with MSS SP-110.
      - b. Manufacturers and Products:
        - 1) Conbraco Apollo; 76F-100 Series.
        - 2) Nibco; T-585-S6-R-66-LL.
    - 2. Type V330 PVC Ball Valve 2 Inches and Smaller:
      - a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride (PVC) body, ball, and stem, end entry, double union design, with solvent-weld socket ends or single union ball, replaceable elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
      - b. Manufacturers and Products:
        - 1) Nibco; Chemtrol Tru-Bloc.
        - 2) ASAHI/America; Type 21.
        - 3) Spears; True Union.
  - C. Butterfly Valves:
    - 1. General:
      - a. In full compliance with AWWA C504 and following requirements:
        - 1) Suitable for throttling operations and infrequent operation after periods of inactivity.

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- 2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
- 3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
- 4) No travel stops for disc on interior of body.
- 5) Self-adjusting V-type or O-ring shaft seals.
- 6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
- 7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
- 8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
- 9) Provide linings and coatings per AWWA, unless otherwise indicated on the Drawings or specified herein.
- 10) Valves to be in full compliance with NSF/ANSI 61. Provide NSF/ANSI 61 certificate for each valve.
- b. Non-AWWA butterfly valves to meet the following actuator requirements:
  - For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on the Drawings or specified herein.
- 2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
  - a. AWWA C504, Class 150B.
  - b. Short body type, flanged ends.
  - c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat, and stainless steel seating surface.
  - d. Provide epoxy lining in compliance with AWWA C550.
  - e. Manufacturers and Products:
    - 1) Pratt; Model 2FII or Triton XR-70.
    - 2) DeZurik; AWWA Valve.
- 3. Type V510 Lug Style Butterfly Valve, Resilient Seated, 2 Inches to 20 Inches for Low Pressure Process Air Service:
  - Lug style cast-iron body, aluminum bronze discs, Type 316 stainless steel one-piece stem, self-lubricating sleeve type bushings, EPDM replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 psi working pressure rating, bubble-tight at 50 psi differential pressure, valve body to fit between ASME B16.1 Class 125/150 flanges.

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- b. Manufacturers and Products:
  - 1) Bray Controls; Series 31.
  - 2) Tyco/Keystone; Model AR2.
- 4. Type V514 High Performance Butterfly Valve 2 Inches to 36 Inches:
  - ASME B16.1 Class 150 lug style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, EPDM seat, PTFE stem packing, stainless steel with RTFE thrust washer.
  - b. Manufacturers and Products:
    - 1) Tyco/Keystone; K-Lok Series.
    - 2) DeZurik; BHP Series.
- D. Check and Flap Valves:
  - 1. Type V608 Swing Check Valve 2 Inches to 24 Inches:
    - a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with bronze seat, stainless steel hinge shaft.
    - b. Valves, 2 inches through 12 inches rated 175-pound WWP and 14 inches through 24 inches rated 150-pound WWP. Valves to be plain fitted. Increasing-pattern body valve may be used where increased outlet piping size is shown.
    - c. Manufacturers and Products:
      - 1) M&H Valve; Style 59, 159, or 259.
      - 2) Mueller Co.; No. A-2600 Series.
  - 2. Type V612 Double Disc Swing Check Valve 14 Inches to 48 Inches:
    - a. Lugged or flanged, spring loaded, cast-iron body, aluminumbronze discs, EPDM resilient seats, and Type 316 stainless steel spring, hinge pin, and stop pin.
    - b. Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550.
    - c. Valves 14 inches through 48 inches between flanges or fully flanged with flanges rated per ASME B16.1 Class 125/150.
    - d. Manufacturers and Products:
      - 1) APCO; Series 9000.
      - 2) Val-Matic; Dual Disc.
      - 3) Tyco; Gulf MB Series.
- E. Self-Regulated Automatic Valves:
  - 1. Type V744 Air Release Valve 1/2 Inch to 2 Inches:
    - a. Suitable for water service, automatically exhaust small amounts of entrained air that accumulates in a system. In CLOSED position, seat against resilient seat to prevent water leakage.

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- b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512. Operating pressure is 20 psi.
- c. Manufacturers and Products:
  - 1) APCO Valve and Primer Corp.; Series 50, 200, and 200A.
  - 2) Val-Matic Valve; Series 15A to 45.6.
- 2. Type V746 Combination Air Release Valve 1 Inch to 16 Inches:
  - a. Suitable for water service, combines operating features of air and vacuum valve and air release valve. Air and vacuum portion to automatically exhaust air during filling of system and allow air to re-enter during draining or when vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system.
  - b. Valve single body or dual body, air release valve mounted on air and vacuum valve, isolation valve mounted between the dual valves. 1-inch through 3-inch valves with NPT threaded inlet and outlet, 4-inch and larger valves with ASME B16.1 Class 125 flanged inlet and cover outlet.
  - c. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
  - d. Manufacturers and Products:
    - 1) APCO Valve and Primer Corp.; Series 143C to 147C or 1804 to 1816.
    - 2) Val-Matic Valve; Series 201C to 203C or 104/22 to 116/38.

#### 2.06 OPERATORS AND ACTUATORS

- A. Manual Operators:
  - 1. General:
    - a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
    - b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
    - c. Operator self-locking type or equipped with self-locking device.
    - d. Position indicator on quarter-turn valves.
    - e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.

- 2. Exposed Operator:
  - a. Galvanized and painted handwheel.
  - b. Cranks on gear type operator.
  - c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
  - d. Valve handles to take a padlock, and wheels a chain and padlock.
- 3. Buried Operator:
  - a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
  - b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
  - c. Buried valves shall have extension stems, bonnets, and valve boxes.
- B. Electric Motor Actuators, 480 Volts:
  - 1. General:
    - a. Comply with latest version of AWWA C542.
    - b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
    - c. Controls integral with actuator and fully equipped as specified in AWWA C542.
    - d. Stem protection for rising stem valves.
  - 2. Actuator Operation—General:
    - a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves, as applicable.
    - b. Manual override handwheel.
    - c. Valve position indication.
    - d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Actuated Valve Schedule.
  - 3. Open-Close(O/C)/Throttling(T) Service:
    - a. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
    - b. Actuator suitable for throttling operation of valve at intermediate positions.
    - c. OPEN and CLOSED indicating lights.
    - d. Integral reversing motor starter with built-in overload protection.
  - 4. Modulating (M) Service:
    - a. Size actuators for continuous modulating duty.
    - b. Feedback potentiometer, or equivalent, and integral electronic positioner/comparator circuit to maintain valve position.

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- c. OPEN and CLOSED indicating lights.
- d. Ac motor with solid state reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Controller capable of 1,200 starts per hour.
- e. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
- f. Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.
- 5. Limit Switch:
  - a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
  - b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
  - c. Housed in actuator control enclosure.
- 6. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
- 7. Manufacturers and Products:
  - a. Rotork Controls.
  - b. Flowserve Limitorque.
  - c. AUMA.
  - d. Beck Electric Actuators.

# 2.07 ACCESSORIES

- A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve operator, bearing valve tag number shown on the Electric Actuated Valve Schedule and Self-Regulated Valve Schedule.
- B. Limit Switch:
  - 1. Factory installed NEMA 4X limit switch by actuator manufacturer.
  - 2. SPST, rated at 5 amps, 120 volts ac.
- C. Cast Iron Valve Box: Designed for traffic loads, with minimum of 5 1/4-inch ID shaft:
  - 1. Box: Cast iron, adjustable shaft, standard Buffalo type.
  - 2. Lid: Shall bear the word Water or the letter W and be painted blue
  - 3. Three piece box and lid for valves larger than 12 inches.
  - 4. Extensions: Cast iron only.

- 5. Debris cap: Shall be comprised of a hollow member having a cylindrical outer surface, a closure for one end and three-point resilient contact pads projecting from the outer surface. One contact pad shall be movable by means of a cam having a low angle of advance whereby external forces applied to the cam via the movable contact pad do not cause rotation of said cam. The cap shall have a flexible skirt providing an outward seal preventing debris from getting past the cap. The cap must withstand, without slippage, a minimum vertical force of 50 pounds, at a loading rate of 1.0 inches/minute. The cap shall be molded using General Electric ABS #HIM 4500 "or-equal". The cap shall have retaining prongs to retain a standard locating coil. Caps shall be blue for water. Locator disk and locking device must be included with the debris cap.
- 6. Manufacturer: Tyler Type 6850.

# PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Flange Ends:
  - 1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
  - 2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
- B. Screwed Ends:
  - 1. Clean threads by wire brushing or swabbing.
  - 2. Apply joint compound.
- C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.
- D. Valve Installation and Orientation:
  - 1. General:
    - a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
    - b. Install valves in location for easy access for routine operation and maintenance.
    - c. Install valves per manufacturer's recommendations.
  - 2. Gate, Globe, and Ball Valves:
    - a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
    - b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

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- 3. Eccentric Plug Valves:
  - a. Unless otherwise restricted or shown on the Drawings, install valve as follows:
    - Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
    - 2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
    - 3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).
- 4. Butterfly Valves:
  - a. Unless otherwise restricted or shown on the Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
  - b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
  - c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
  - d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
  - e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
- 5. Check Valves:
  - a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
  - b. Install valve in vertical flow (up) piping only for gas services.
  - c. Install swing check valve with shaft in horizontal position.
  - d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
- 6. Solenoid Valves: Install in accordance with manufacturer's instructions.
- E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.
- F. Install safety isolation valves on compressed air.
- G. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.
- H. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

- I. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.
- J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.
- K. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate "L" type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

#### 3.02 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for relief and regulating valves.
- F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.
- G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

# 3.03 MANUFACTURER'S SERVICES

- A. Valve(s) as listed below require manufacturer's field services:
  - 1. V504, V510, V514, V754, V135.

- B. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:
  - 1. 1 person-days for installation assistance and inspection.
  - 2. 1 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
- C. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

### 3.04 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are part of this Specification.
  - 1. Electric Actuated Valve Schedule.
  - 2. Self-Regulated Valve Schedule.

# **END OF SECTION**

Electric Actuated Valve Schedule									
Tag Number	Valve Type	Actuator Power Supply	Valve Size (inches)	Process Fluid	Maximum Operating Flow (gpm)	Maximum ΔP (psi)	Service	Travel Time (Seconds)	Control Feature Modifications/ Supplements
FV-40-101	V500	480-volt, three-phase	8	RW	3,000	33.5	O/C	60	С
FV-40-102	V500	480-volt, three-phase	8	RW	3,000	33.5	O/C	60	С
FV-40-103	V500	480-volt, three-phase	18	BWD	6,000	33.5	O/C	60	С
FV-40-104	V500	480-volt, three-phase	18	BWD	6,000	33.5	O/C	60	С
FV-40-105	V500	480-volt, three-phase	16	FI/BWS	6,000	33.5	O/C	60	С
FV-40-106	V500	480-volt, three-phase	16	FI/BWS	6,000	33.5	O/C	60	С
FV-40-107	V510	480-volt, three-phase	6	ALP	1,200 SCFM	33.5	O/C	60	С
FV-40-108	V510	480-volt, three-phase	6	ALP	1,200 SCFM	33.5	O/C	60	С
FV-40-109	V500	480-volt, three-phase	16	BWS	6,000	33.5	O/C	60	С
FCV-40-110	V514	480-volt, three-phase	16	FI/BWS	6,000	33.5	М	60	C,J
FV-40-111	V500	480-volt, three-phase	16	FI	3,100	33.5	O/C	60	С
FV-40-112	V500	480-volt, three-phase	16	FI/D	3,100	33.5	O/C	60	С
FCV-40-121	V514	480-volt, three-phase	16	BWS	6,000	27.5	М	60	C,J
FV-40-201	V500	480-volt, three-phase	8	RW	3,000	33.5	O/C	60	С
FV-40-202	V500	480-volt, three-phase	8	RW	3,000	33.5	O/C	60	С
FV-40-203	V500	480-volt, three-phase	18	BWD	6,000	33.5	O/C	60	С
FV-40-204	V500	480-volt, three-phase	18	BWD	6,000	33.5	O/C	60	С
FV-40-205	V500	480-volt, three-phase	16	FI/BWS	6,000	33.5	O/C	60	С
FV-40-206	V500	480-volt, three-phase	16	FI/BWS	6,000	33.5	O/C	60	С
FV-40-207	V510	480-volt, three-phase	6	ALP	1,200 SCFM	33.5	O/C	60	С
FV-40-208	V510	480-volt, three-phase	6	ALP	1,200 SCFM	33.5	O/C	60	С

### PROCESS VALVES AND OPERATORS 40 27 02 SUPPLEMENT 1 - 1

Electric Actuated Valve Schedule									
Tag Number	Valve Type	Actuator Power Supply	Valve Size (inches)	Process Fluid	Maximum Operating Flow (gpm)	Maximum ∆P (psi)	Service	Travel Time (Seconds)	Control Feature Modifications/ Supplements
FV-40-209	V500	480-volt, three-phase	16	BWS	6,000	33.5	O/C	60	С
FCV-40-210	V514	480-volt, three-phase	16	FI/BWS	6,000	33.5	М	60	C,J
FV-40-211	V500	480-volt, three-phase	16	FI	3,100	33.5	O/C	60	С
FV-40-212	V500	480-volt, three-phase	16	FI/D	3,100	33.5	O/C	60	С

Service: O/C = Open-Close, T = Throttling, M = Modulating

Control Feature Modifications/Supplements:

A = Actuator shall open valve upon loss of signal.

B = Actuator shall close valve upon loss of signal.

C = Actuator shall remain in last position upon loss of signal.

D = Local OPEN-CLOSE momentary pushbuttons that must be continuously depressed to initiate/maintain valve travel; travel stops when pushbutton is released or when end of travel limit is reached.

E = Remote OPEN-CLOSE maintained dry contacts; travel stops when remote contact opens, or when end of travel limit is reached.

F = Three 24-volt dc interposing relays for remote OPEN-STOP-CLOSE control. Relays powered externally, thereby permitting valve control from greater distances.

G = Motor and control enclosure(s) NEMA 250, Type 4 with 480-volt space heaters.

H = Motor and control enclosure(s) NEMA 250, Type 6 (IP 68) with 480-volt space heaters.

I = Motor and control enclosure(s) NEMA 250, Type 7 with 480-volt space heaters.

J = Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.

K = 480-volt secondary control power transformer.

L = Externally operable power disconnect switch.

PROCESS VALVES AND OPERATORS 40 27 02 SUPPLEMENT 1 - 2

Self-Regulated Valve Schedule									
Tag No.	Valve Type No.	Size (inches)	Inlet* Pressure	Outlet* Pressure	Maximum psig	Flow (gpm)	Fluid		
ARV-40-101	V744	2			33.5	6,000	Backwash Supply		
ARV-40-102	V744	2			33.5	6,000	Filtrate		
ARV-40-103	V744	2			33.5	6,000	Raw Water		
ARV-40-113	V746	2			35.5	3,000	Raw Water		
ARV-40-114	V746	2			35.5	3,000	Raw Water		
ARV-40-115	V746	2			35.5	3,000	Raw Water		
ARV-40-131	V744	2			33.5	6,000	Raw Water		
ARV-40-213	V746	2			35.5	3,000	Raw Water		
ARV-40-214	V746	2			35.5	3,000	Raw Water		
ARV-40-215	V746	2			35.5	3,000	Raw Water		
*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.									

## SECTION 40 80 01 PROCESS PIPING LEAKAGE TESTING

# PART 1 GENERAL

## 1.01 SUBMITTALS

- A. Informational Submittals:
  - 1. Testing Plan:
    - a. Submit prior to testing and include at least the information that follows.
      - 1) Testing dates.
      - 2) Piping systems and section(s) to be tested.
      - 3) Test type.
      - 4) Method of isolation.
      - 5) Calculation of maximum allowable leakage for piping section(s) to be tested.
  - 2. Certifications of Calibration: Testing equipment.
  - 3. Certified Test Report.

# PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

#### 3.01 PREPARATION

- A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.
- B. Pressure Piping:
  - 1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
  - 2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
  - 3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
  - 4. New Piping Connected to Existing Piping:
    - a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
    - b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

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- 5. Items that do not require testing include: Equipment seal drains, and tank atmospheric vents.
- 6. Test Pressure: As indicated on Piping Schedule, supplemental to Section 40 27 00, Process Piping General.
- C. Test section may be filled with water and allowed to stand under low pressure prior to testing.
- D. Gravity Piping:
  - 1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
  - 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
  - 3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

### 3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Exposed Piping:
  - 1. Perform testing on installed piping prior to application of insulation.
  - 2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
  - 3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
  - 4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
  - 5. Examine joints and connections for leakage.
  - 6. Correct visible leakage and retest as specified.
  - 7. Empty pipe of water prior to final cleaning or disinfection.
- C. Buried Piping:
  - 1. Test after backfilling has been completed.
  - 2. Expel air from piping system during filling.
  - 3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
  - 4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
  - 5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

PROCESS PIPING LEAKAGE TESTING 40 80 01 - 2
6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148,000}$$

where:

L	=	Allowable leakage, in gallons per hour.
---	---	---

- S = Length of pipe tested, in feet. D = Nominal diameter of pipe, in inches. P = Test pressure during leakage test, in pounds per square inch.
- 7. Correct leakage greater than allowable, and retest as specified.

# 3.03 PNEUMATIC TEST FOR PRESSURE PIPING

- A. Do not perform on:
  - 1. PVC or CPVC pipe.
  - 2. Piping larger than 18 inches.
  - 3. Buried and other non-exposed piping.
- B. Fluid: Oil-free, dry air.
- C. Procedure:
  - 1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
  - 2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
  - 3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
  - 4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
  - 5. Correct visible leakage and retest as specified.
- D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
- E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

#### SWF BAF IMPROVEMENTS

## 3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.
- B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
- C. Exfiltration Test:
  - 1. Hydrostatic Head:
    - a. At least 6 feet above maximum estimated groundwater level in section being tested.
    - b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
  - 2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.
- D. Infiltration Test:
  - 1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.
- E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- F. Defective Piping Sections: Replace, and retest as specified.

#### 3.05 FIELD QUALITY CONTROL

- A. Test Report Documentation:
  - 1. Test date.
  - 2. Description and identification of piping tested.
  - 3. Test fluid.
  - 4. Test pressure.
  - 5. Remarks, including:
    - a. Leaks (type, location).
    - b. Repair/replacement performed to remedy excessive leakage.
  - 6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

## **END OF SECTION**

PROCESS PIPING LEAKAGE TESTING 40 80 01 - 4

## SECTION 40 90 00 INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

# PART 1 GENERAL

## 1.01 SUMMARY

- A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:
  - 1. Section 40 91 00, Instrumentation and Control Components.
- B. Work is divided between scope for the process instrumentation and control supplier (PICS) and scope for the Package System Provider.
- C. In general, Work Includes: Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Owner training for complete process instrumentation and control (PIC) for plant operation.
- D. PICS Work Includes:
  - 1. Furnishing and installing a new control panel and major supervisory control and data acquisition (SCADA) system components as shown on piping and instrumentation diagrams (P&IDs).
  - 2. Furnishing and installing new fiber-optic Ethernet cabling and copper Ethernet (CAT6) cabling as shown on P&IDs. Creating a fiber ring between new PICS control and package system supplier control panels as shown on P&IDs.
  - 3. Furnishing and installing new instruments and network switches as shown on P&IDs.
  - 4. Furnishing and installing a new, larger SCADA network rack near CP-1 as shown on P&IDs. This activity includes:
    - a. Documenting network switch connections and ports, removing and properly storing network equipment from the two existing SCADA network racks.
    - b. Demolition of the two existing SCADA network racks.
    - c. Installing a new, larger SCADA network rack.
    - d. Reinstalling the network equipment that was removed from the two demoed SCADA network racks into this new SCADA network rack and properly reconnecting equipment to appropriate ports.
    - e. Submit design details and Drawings to Owner and Engineer for review and approval.

- 5. Field and Panel wiring of PICS instruments, valves, and equipment as shown on P&IDs.
- 6. Field and Panel wiring package system supplier's instruments, valves, and equipment as shown on P&IDs.
- 7. Field and Panel wiring of VFD input/output (I/O) signals into CP-1 as shown on P&IDs.
- 8. Installing a new UPS inside CP-1 as shown on P&IDs.
- 9. Programming existing and new programmable logic controllers (PLCs) and existing and new human machine interfaces (HMIs) for process control and SCADA integration. The existing PLCs are Automation Direct PLCs, and the existing HMIs are VTScada HMI nodes.
  - a. Program PLC-1 and PLC-30 to accomplish loop specifications as determined in Supplement 4, Loop Specifications.
  - b. Develop and deploy new SCADA HMI screens to accomplish loop specifications as determined in Supplement 4, Loop Specifications.
  - c. Program HMI client at CP-30 as a new remote node.
  - d. Program HMI client at CP-1 with new SCADA HMI screens.
  - e. Deploy changes to greater SCADA HMI system at remote plants and sites. Coordinate with Owner on locations and requirements.
- 10. Program CP-1 to monitor and alarm on pump and equipment activity to potentially mitigate a power overload of the plant's main transformer.
  - a. Monitor the total number of pumps (and equipment) called to run.
  - b. Prevent additional pumps (and equipment) from running if near threshold of total number of active pumps (and equipment).
  - c. Provide notifications and alarms on plant's SCADA HMI system.
- 11. Integrating the Package System Supplier's control panel(s) into the plant's SCADA HMI system.
- 12. Integrating the backwash pump panel and aeration blower system into the plant's SCADA HMI system.
- 13. Testing and verifying all Field and Panel wiring, I/O signals, and connectivity into the existing plant fiber network.
- 14. Testing and verifying SCADA integration of new processes and equipment.
- E. Package System Supplier Work Includes:
  - 1. Furnishing and installing a new control panel and networking components as shown on P&IDs.
  - 2. Furnishing and installing instruments, networking devices, and equipment as shown on P&IDs
  - 3. Programming package system supplier PLC and operator interface terminal (OIT) to accomplish control narrative set forth in the process mechanical specifications, and to accomplish any related loop specifications as determined in Supplement 4, Loop Specifications.

- 4. Coordinate and provide a data exchange table of process information, interlocks, and alarms to be transferred between package system supplier's PLC and the SCADA system.
- 5. Coordinate IP addresses of package system supplier's PLC, OIT, network switch, and equipment with Owner and PICS.
- F. SCADA HMI Programming and Integration:
  - 1. The SCADA HMI system for the plant is a VTScada software system, version 11.2.14. It is one of several nodes in the overall Marco Island VTScada system. Refer to 40 90 00 Supplement 5, Plant VTScada Sample Information for additional system descriptions and sample screens for reference.
  - 2. Additional SCADA functions such as the historization and trending of data, compliance report generation, and remote alarm notification shall be discussed with Owner and Engineer in a workshop setting to determine final requirements.
  - 3. Integration into VTScada will increase the I/O point total. PICS shall purchase additional I/O points, or upgrade the Owner's current VTScada license as necessary to provide a complete functional system.
- G. Detailed Design: PIC as shown and specified includes functional and performance requirements and component specifications. Complete detailed PIC design.

## 1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
    - b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
    - c. A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
    - d. B32, Standard Specification for Solder Metal.
    - e. B88, Standard Specification for Seamless Copper Water Tube.
  - 2. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
  - 3. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems— Local and Metropolitan Networks.

- 4. Insulated Cable Engineers Association (ICEA):
  - a. S-83-596, Optical Fiber Premises Distribution Cable.
  - b. S-87-640, Optical Fiber Outside Plant Communications Cable.
  - c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
- 5. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
- 6. International Society of Automation (ISA):
  - a. PR12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
  - b. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
  - c. S5.4, Standard Instrument Loop Diagrams.
  - d. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
  - e. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
- 7. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
- 8. National Electrical Manufacturers Association (NEMA):
  - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  - b. ICS 1, General Standards for Industrial Control and Systems.
- 9. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
- 10. National Institute of Standards and Technology (NIST).
- 11. NSF International (NSF):
  - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
  - b. NSF/ANSI 372, Drinking Water System Components Lead Content.
- 12. QuEST Forum (QF): TL 9000, Quality Management Systems.
- 13. Rural Development Utilities Programs (RDUP):
  - a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
  - b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
- 14. Telecommunications Industry Association (TIA):
  - a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
  - b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
  - c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
  - d. 568-C.3, Optical Fiber Cabling Components Standard.
  - e. 598, Optical Fiber Cable Color Coding.

- f. 606, Administration Standard for Commercial Telecommunications Infrastructure.
- 15. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
  - a. 455-78, FOTP-78 IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.
  - b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
  - c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
  - d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
  - e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
  - f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
  - g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
  - h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
  - i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
  - j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
  - k. 942, Telecommunications Infrastructure Standard for Data Centers.
  - 1. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.
- 16. UL:
  - a. 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
  - b. 508A, Standard for Safety, Industrial Control Panels.

## 1.03 DEFINITIONS

- A. Abbreviations:
  - 1. ASP: Automation solution provider.
  - 2. ATM: Asynchronous transfer mode.
  - 3. AUI: Attachment unit interface.
  - 4. dB: Decibel.
  - 5. DNI: Desktop network interface.

- 6. EMB: Effective modal bandwidth.
- 7. ESW: Ethernet switch.
- 8. ETL: Electrical test laboratories.
- 9. FDDI: Fiber distributed data interface.
- 10. FIM: Facilities information management.
- 11. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.
- 12. FOCS: Fiber-optic communication system.
- 13. FOIRL: Fiber-optic inter repeater link.
- 14. FOPP: Fiber-optic patch panel.
- 15. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.
- 16. HMI: Human-machine interface.
- 17. Hybrid Cable: Cable containing more than one type of fiber.
- 18. I&C: Instrumentation and control.
- 19. I/O: Input/output.
- 20. LAN: Local area network.
- 21. LCP: Local control panel.
- 22. LIMS: Laboratory information management system.
- 23. m: Micrometer.
- 24. Mbps: Megabits per second.
- 25. MCC: Motor control center.
- 26. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.
- 27. Megahertz (MHz): One million cycles per second.
- 28. MHz: Megahertz.
- 29. micro: x 10<sup>-6</sup>.
- 30. Micron: Micrometer or one millionth meter.
- 31. MIS: Management information system.
- 32. n, nano: x 10<sup>-9</sup>.
- 33. N: Newton.
- 34. nm: Nanometer—unit of measure equal to one billionth meter.
- 35. OFL: Over-filled launch.
- 36. OFN: Nonconductive optical fiber cable.
- 37. OFNP: Nonconductive optical fiber plenum cable.
- 38. OFNR: Nonconductive optical fiber riser cable.
- 39. OLTS: Optical loss test sets.
- 40. OTDR: Optical time domain reflectometer.
- 41. OVD: Outside vapor deposit.
- 42. PAT: Performance acceptance test.
- 43. PIC: Process instrumentation and control.
- 44. PICS: Process instrumentation and control supplier.
- 45. PLC: Programmable logic controller.

- 46. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.
- 47. RLM: Restricted mode launch.
- 48. ROL: Reverse oscillation lay.
- 49. SCADA: Supervisory control and data acquisition.
- 50. SPC: Super physical contact.
- 51. UPC: Ultra physical contact.
- 52. UPS: Uninterruptible power supply.
- 53. UV: Ultraviolet.
- 54. V ac: Volts, alternating current.
- 55. WAN: Wide area network.
- B. Enclosure: Control panel, console, cabinet, or instrument housing.
- C. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.
  - System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
  - 2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
  - 3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.
- D. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
  - 1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
  - 2. Programming in any programming or scripting language.
- E. Rising/Falling: Define action of discrete devices about their setpoint.
  - 1. Rising: Contacts close when an increasing process variable rises through setpoint.

- 2. Falling: Contacts close when a decreasing process variable falls through setpoint.
- F. Signal Types:
  - 1. Analog Signal, Current Type:
    - a. 4 to 20 mA dc signals conforming to ISA S50.1.
    - b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      - 1) Transmitter Type: Number 2, two-wire.
      - 2) Transmitter Load Resistance Capacity: Class L.
      - 3) Fully isolated transmitters and receivers.
  - 2. Analog Signal, Voltage Type: 1 to 5 volts dc within panel where common high precision dropping resistor is used.
  - 3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
  - 4. Pulse Frequency Signals:
    - a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
    - b. Pulses generated by contact closures or solid state switches.
    - c. Power source less than 30V dc.
  - 5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.
- G. Instrument Tag Numbers: Instrument tag numbers are shown on the Drawings and process and instrumentation diagrams (P&IDs) and referenced in Article Supplements at end of section.

#### 1.04 SYSTEM DESCRIPTION

- A. Design Requirements:
  - 1. Complete detailed design of PIC components and PIC drawings.
  - 2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
  - 3. PIC design as shown and specified includes:
    - a. Functional requirements, performance requirements, and component specifications.
    - b. P&IDs, block diagrams, and network diagrams.
  - 4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

- B. Use a qualified PIC System Integrator for at least the following work:
  - 1. For PIC Equipment and Ancillaries:
    - a. Completing detail design.
      - b. Submittals.
      - c. Equipment, enclosures, and ancillaries.
      - d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
      - e. Verify readiness for operation.
      - f. Verify correctness of final power and signal connections (lugging and connecting).
      - g. Adjusting and calibrating.
      - h. Starting up.
      - i. Testing and coordination of testing.
      - j. Training.
    - k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.
  - 2. Verify following Work not by PIC System Integrator is provided:
    - a. Correct type, size, and number of signal wires with their raceways.
    - b. Correct electrical power circuits and raceways.
    - c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
    - d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
  - 3. Non-PIC Equipment Directly Connected to PIC Equipment:
    - a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
    - b. Coordinate with Contractor to allow required interface and operation with PIC.
    - c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
    - d. Test to demonstrate required interface and operation with PIC.
    - e. Examples of items in this category, but not limited to the following:
      - 1) Valve operators, position switches, and controls.
      - 2) Chemical feed pump and feeder speed/stroke controls.
      - 3) Automatic samplers.
      - 4) Motor control centers.
      - 5) Adjustable speed and adjustable frequency drive systems.
    - f. Examples of items not in this category:
      - 1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
      - 2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

## 1.05 SUBMITTALS

- A. General:
  - 1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
  - 2. Partial Submittals not in accordance with Project Schedule will not be accepted.
  - 3. Submittal Format:
    - a. Hard Copy: Required for all submittals.
    - b. Electronic Copies: Required, unless otherwise noted for specific items.
      - 1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
      - 2) Documents created specifically for Project:
        - a) Text and Graphics: Microsoft Word.
          - b) Lists: Microsoft Excel, unless otherwise noted for specific items.
          - c) Drawings: AutoCAD.
  - 4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
  - 5. Legends and Abbreviation Lists:
    - a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
    - b. Use identical abbreviations in PIC subsections.
    - c. Submit updated versions as they occur.
  - 6. Activity Completion:
    - a. Action Submittals: Completed when reviewed and approved.
    - b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.
- B. Action Submittals:
  - 1. General:
    - a. Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.
    - b. Identify proposed items and options. Identify installed spares and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
    - c. Legends and Abbreviation Lists: Complete definition of symbols and abbreviations used on this Project (for example, engineering units, flow streams, instruments, structures, and other process items used in nameplates, legends, and data sheets).

- 2. Bill of Materials: List of required equipment.
  - a. Group equipment items by enclosure and field, and within an enclosure, as follows:
    - 1) Instrumentation and Control (I&C) Components: By component identification code.
    - 2) Other Equipment: By equipment type.
  - b. Data Included:
    - 1) Equipment tag number.
    - 2) Description.
    - 3) Manufacturer, complete model number, and all options not defined by model number.
    - 4) Quantity supplied.
    - 5) Component identification code where applicable.
- 3. Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices.
  - a. Catalog information, mark to identify proposed items and options.
  - b. Descriptive literature.
  - c. External power and signal connections.
  - d. Scaled Drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
- 4. Component Data Sheets: Data sheets for I&C components.
  - a. Format and Level of Detail: In accordance with ISA-S20.
  - b. Include component type identification code and tag number on data sheet.
  - c. Specific features and configuration data for each component:
    - 1) Location or service.
    - 2) Manufacturer and complete model number.
    - 3) Size and scale range.
    - 4) Setpoints.
    - 5) Materials of construction.
    - 6) Options included.
  - d. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
- 5. Sizing and Selection Calculations:
  - a. Primary Elements: Complete calculations plus process data used. Example, for flow elements, minimum and maximum values, permanent head loss, and assumptions made.
  - b. Controlling, Computing and Function Generating Modules: Actual scaling factors with units and how they were computed.
- 6. Panel Construction the Drawings:
  - a. Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
  - b. Panel Legend: List front-of-panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.

- c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
- d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
- e. Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.
- 7. Panel Control Diagrams: For discrete control and power circuits.
  - a. Diagram Type: Ladder diagrams in format same as shown on the Drawings. Include devices, related to discrete functions, that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.
  - b. Item Identification: Identify each item with attributes listed.
    - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
    - 2) Terminals: Use wire numbers to identify terminals.
    - 3) Discrete Components:
      - a) Tag number, terminal numbers, and location ("FIELD," enclosure number, or MCC number).
      - b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
    - 4) Relay Coils:
      - a) Tag number and its function.
      - b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
    - 5) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
  - c. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be permitted.
  - d. Ground wires, surge protectors, and connections.
  - e. Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.
- 8. Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.
- 9. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for pipes and tubes: Thickness, pressure rating, and materials.
  - a. Components: Valves, regulators, and filters.
  - b. Connections to panel-mounted devices.
  - c. Panel interface connections.

- 10. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.
  - a. Conform to the minimum requirements of ISA S5.4.
  - b. Under Paragraph 5.3 of ISA S5.4, include the information listed under subparagraphs 2 and 6.
  - c. Drawing Size: 11-inch by 17-inch sheet. Multiple loops can be drawn on a single sheet where space permits.
  - d. Divide each loop diagram into areas for panel face, back-of-panel, and field.
  - e. Show:
    - 1) Terminal numbers (use wire numbers to identify terminals), location of dc power supply, and location of common dropping resistors.
    - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
    - 3) Tabular summary on each diagram:
      - a) Transmitting Instruments: Output capability.
      - b) Receiving Instruments: Input impedance.
      - c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
      - d) Total loop impedance.
      - e) Reserve output capacity.
    - 4) Circuit and raceway schedule names.
- 11. Interconnecting Wiring Diagrams:
  - a. Diagrams, device designations, and symbols in accordance with NEMA ICS 1.
  - b. Diagrams shall bear electrical subcontractor's signature attesting diagrams have been coordinated with Division 26, Electrical.
  - c. Show:
    - 1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
    - 2) Component and panel terminal board identification numbers, and external wire and cable numbers.
    - 3) Circuit names matching Circuit and Raceway Schedule.
    - 4) Intermediate terminations between field elements and panels (for example, to terminal junction boxes and pull boxes).
    - 5) Pull boxes.
- 12. Installation Details: Include modifications or further details required to adequately define installation of I&C components.
- 13. Fiber-optic Cable Details: Provide information on fiber cable testing to include, but not limited to:
  - a. Factory testing results.
  - b. Pre-installation and post-installation testing results.

- 14. Fiber-optic Network Integration Details: Include Drawings or further details required to adequately integrate new control panels into the existing plant fiber ring network.
- 15. Design drawings for the new network cabinet.
- 16. Field investigation report from PICS subcontractor that provides details for items that required verification.
- 17. Sequence plan for outage and replacement timeline.
- C. Informational Submittals: For PIC equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.
  - 1. Owner training plan.
  - 2. Operation and Maintenance (O&M) Manuals:
    - a. Content and Format:
      - 1) Complete sets O&M manuals.
      - 2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PIC component.
      - 3) Final versions of legend and abbreviation lists.
      - b. Include:
        - 1) P&IDs: One reproducible copy of revised P&ID to reflect as-built PIC design.
        - 2) Refer to paragraph Shop Drawings for the following items:
          - a) Bill of materials.
          - b) Catalog cuts.
          - c) Component data sheets.
          - d) Panel control diagrams.
          - e) Panel wiring diagrams, one reproducible copy.
          - f) Panel plumbing diagrams, one reproducible copy.
          - g) Loop diagrams, one reproducible copy.
          - h) Interconnecting wiring diagrams, one reproducible copy.
          - i) System integration documentation.
        - 3) Device O&M manuals for components, electrical devices, and mechanical devices include:
          - a) Operations procedures.
          - b) Installation requirements and procedures.
          - c) Maintenance requirements and procedures.
          - d) Troubleshooting procedures.
          - e) Calibration procedures.
          - f) Internal schematic and wiring diagrams.
          - g) Component Calibration Sheets from field quality control calibrations.
        - 4) List of additional spares, expendables, test equipment, and tools recommended.

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- 3. Performance Acceptance Tests (PAT) Submittals:
  - a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
  - b. Final Test Procedures: Proposed test procedures, forms, and checklists.
  - c. Test Documentation: Copy of signed off test procedures when tests are completed.

#### 1.06 QUALITY ASSURANCE

- A. Calibration Instruments: Each instrument used for calibrating PIC equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the NIST.
- B. Coordination Meetings:
  - 1. Attended By: Engineer, Owner, and Contractor.
  - 2. Minimum of three are required. Specific dates will be established in progress schedule.
  - 3. First Meeting: Within 14 days after Notice to Proceed.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Provide Site and warehouse storage facilities for PIC equipment.
- B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.
- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

#### 1.08 SEQUENCING AND SCHEDULING

- A. Activity Completion: The following is a list of key activities and their completion criteria.
  - 1. Shop Drawings: Reviewed and approved.
  - 2. Quality Control Submittals: Reviewed and accepted.
  - 3. Hardware Delivery: Hardware delivered to Site and inventoried by Owner and Contractor.
  - 4. PAT: Completed and required test documentation accepted.

- B. PIC Substantial Completion: When Engineer issues Certificate of Substantial Completion.
  - 1. Prerequisites:
    - a. All PIC submittals have been completed.
    - b. PIC has successfully completed PAT.
    - c. Owner training plan is on schedule.
- C. PIC Acceptance: When Engineer issues a written notice of Final Payment and Acceptance.
  - 1. Prerequisites:
    - a. Certificate of Substantial Completion issued for PIC.
    - b. Punchlist items completed.
    - c. Final revisions to O&M manuals accepted.
    - d. Maintenance service agreements for PIC accepted by Owner.
- D. Prerequisite Activities and Lead Times: Coordinate with Owner and Engineer during coordination meeting.

## 1.09 EXTRA MATERIALS

- A. As specified in PIC subsections.
- B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.
- C. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
Annunciator light bulbs	20	10
Annunciator window module	10	5
dc power supplies	20	2
Fuses	20	5
Indicating light bulb	20	10
Relays	20	3
Terminal Blocks	10	10
Hand Switches and Lights	10	5
120V ac Isolation Transformers	10	2
Surge Suppressors	10	2

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- D. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.
  - 1. Chemical for analyzers.
  - 2. Calibration/test gas for combustible gas detection.
  - 3. Corrosion-inhibiting vapor capsules.
  - 4. pH sensor overhaul kits: Two.
  - 5. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

## PART 2 PRODUCTS

- 2.01 GENERAL
  - A. PIC functions as shown on the Drawings and as required for each loop. Furnish equipment items as required. Furnish all materials, equipment, and software, necessary to effect required system and loop performance.
  - B. First-named Manufacturer: PIC design is based on first named manufacturers of equipment and materials.
    - 1. If an item is proposed from other than first-named manufacturer, obtain approval from Engineer for such changes in accordance with Article Submittals.
    - 2. If using proposed item requires other changes, provide work and equipment to implement these changes. Changes that may be required include, but are not limited to: different installation, wiring, raceway, enclosures, connections, isolators, intrinsically safe barriers, software, and accessories.
  - C. Like Equipment Items:
    - 1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
    - 2. Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.
  - D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the authority having jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
    - 1. Use or reuse of components and materials without a traceable certification is prohibited.

#### SWF BAF IMPROVEMENTS

#### 2.02 ENVIRONMENTAL REQUIREMENTS

- A. Standard Environmental Requirements: The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the environmental requirements for individual equipment units Unless otherwise noted, design equipment for continuous operation in the following environments.
  - 1. Freestanding Panel and Consoles:
    - a. Inside, Air Conditioned: NEMA 1.
    - b. Inside: NEMA 12.
    - c. Outside, Corrosive: NEMA 4X.
  - 2. Smaller Panels and Assemblies (that are not Freestanding):
    - a. Inside, Air Conditioned: NEMA 12.
    - b. All Other Locations: NEMA 4X.
  - 3. Field Elements: Outside.
- B. Environmental Design Requirements: Following defines the types of environments referred to hereinabove.
  - 1. Inside, Air Conditioned:
    - a. Temperature:
      - 1) Normal: 60 to 80 degrees F.
      - 2) With Up to 4-Hour HVAC System Interruptions: 40 to 105 degrees F.
    - b. Relative Humidity:
      - 1) Normal: 10 percent (winter) to 70 percent (summer).
      - 2) With Up to 4-Hour HVAC System Interruption: 10 to 100 percent.
    - c. NEC Classification: Nonhazardous.
  - 2. Outside, Corrosive:
    - a. Temperature: Minus 20 to 104 degrees F.
    - b. Relative Humidity: 0 to 100 percent, rain.
    - c. Corrosive Environment: Sea air.
    - d. NEC Classification: Nonhazardous.

#### 2.03 LOOP SPECIFICATIONS

- A. Location: 40 90 00 Supplement 4, Loop Specifications.
- B. Functional Requirements for Control Loops:
  - 1. Shown on the Drawings and P&IDs. P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on the Drawings.
  - 2. PICS or PICS integrator shall meet with Owner and Engineer in a workshop setting to solidify functional requirements.

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## 2.04 I&C COMPONENTS

- A. All I&C components shall be provided by PICS.
- B. Components for Each Loop: Major components for each loop are listed in Section 40 91 00, Instrumentation and Control Components, and in Instrument List referenced in Article Supplements. Furnish all equipment that is necessary to achieve required loop performance.

#### 2.05 SCADA SYSTEM COMPONENTS

- A. Unless the Owner decides otherwise, SCADA system components shall be furnished by PICS as specified below.
- B. SCADA Network Panel:
  - 1. Furnish at CP-1.
  - 2. Industrial server rack style cabinet/cage: Vented sides; Solid top, bottom; Harsh environment.
  - 3. Size:
    - a. Field investigate and size as necessary to house networking equipment. Network panel may be wall-mounted or freestanding.
      - 1) For wall-mounted units, submit installation details and Drawings to Owner and Engineer for approval prior to start of work.
    - b. Size for adequate heat dissipation.
    - c. Minimum 12U network cabinet cage.
  - 4. Features:
    - a. Locking cabinet.
    - b. Dust filters, Fans.
      - 1) Positive air pressure/flow/displacement.
    - c. Load capacity: minimum 200 pounds.
    - d. Space for DIN rail-mounted switch.
  - 5. Manufacturer:
    - a. Tripp-Lite.
    - b. APC.
    - c. iStar.

#### 2.06 MULTIMODE FIBER-OPTIC CABLE

- A. Unless the Owner decides otherwise, fiber-optic cables and components shall be furnished by PICS as specified below.
- B. Fiber-optic Cable, Multimode:
  - Fiber Characteristics: Multimode Indoor/Outdoor:
     a. Comply with TIA/EIA 568-C.3 and ANSI X3T9.5.

- b. Graded Index Glass:
  - 62/125 µm graded-index glass for new installation between the SCADA Network Cabinet and cabinets in the Horizontal Pressure Filters Area, as seen on Drawing 08-N-701.
  - Field investigate to determine existing fiber graded index glass between HSP SCADA Network Cabinet and ASR Well Pump Building Cabinet at plant. After investigation, install fiber that was determined to be found between SCADA Network Cabinet and ASR Well Control Panel.
- c. Tight-Buffered, 900 µm buffer.
- d. Maximum Attenuation:
  - 1) 850 nm: 3.0 dB/km.
  - 2) 1,300 nm: 1.0 dB/km.
- e. Minimum Bandwidth:
  - 1) Effective Modal Bandwidth: 5350 MHz-km.
  - Color-coded buffer in accordance with TIA/EIA 598.
- g. Minimum Bend Radius, Buffered Fiber: 1 inch.
- 2. Cable:

f.

- a. Fiber Count:
  - 1) Multimode: 12 fibers per cable, minimum.
- b. All Dielectric Construction: No electrically conductive components in fiber-optic cable are allowed.
- c. Gel-free: Fibers tight-buffered, not in gel-filled loose-tube.
- d. Style: Break-out.
- e. Strength Member:
  - 1) Nonconductive; integral part of cable; supports stress of installation and load during use.
  - 2) Fiberglass epoxy rod, aramid fiber, Kevlar.
  - 3) Minimum Tensile Strength: 600 pounds.
- f. Protective Covering: Continuous and free from holes, splices, blisters, and other imperfections.
- g. Minimum Bend Radius:
  - 1) Short-term under Tension: 20 times cable diameter.
  - 2) Long-term without Tension: 15 times cable diameter.
- h. Identification:
  - 1) Identify with tags shown and in accordance with this section.
  - 2) Use waterproof tags and identifications.
- i. Special Features:
  - 1) Indoor Use: Must be flame-retarded.
  - 2) Outdoor Use:
    - a) UV-resistant.
      - b) Suitable for installation in buried conduit.
    - c) Suitable for Aerial Lashing: If noted.

- d) Suitable for Direct-buried (no Conduit): If noted.
- e) Armored: If noted.
- 3) Indoor Use: Plenum rating not required for indoor use, if fiber is installed in either a tray or riser. Rating must be either tray or riser, as applicable.
- j. Manufacturer and Model: Corning; FREEDM® cables, singlejacket.
- C. Connectors:
  - 1. General:
    - a. Prior to procuring connectors, confirm with Owner and Engineer connector style.
    - b. Use LC connectors for new installation between SCADA Network Cabinet and new cabinets inside the Horizontal Pressure Filters Area.
    - c. Field investigate for existing connectors located between the SCADA Network Cabinet and the ASR Transfer Pumps Control Panel. Use these found connectors for the connection between the SCADA Network Cabinet and the ASR Well Control Panel.
  - 2. Features:
    - a. In accordance with requirements of TIA/EIA 568-C.3, Section 12.4.3 or Annex F.
    - b. (Refer to 1. General a. for new connectors) LC connectors with 12.7 millimeter spacing between ferrules.
    - c. Pull Strength: 0.2 N minimum.
    - d. Durability: Sustain minimum 500 mating cycles without violating other requirements.
      - 1) Ferrules: Free-floating low loss ceramic.
      - 2) Polarizing key on duplex connector systems.
  - 3. Quantity: Connectorize fibers, minimum per cable:
    - a. Multimode: 12.
  - 4. Attenuation:
    - a. In accordance with requirements of TIA/EIA 568, Section 12.4.4.
    - b. Maximum of 0.75 dB per connector pair.
  - 5. Manufacturer: AMP.
- D. Jumper Cables:
  - 1. In accordance with requirements of TIA/EIA 568, Section 12.5.
  - 2. Function: To connect from patch panels to network nodes, such as computer workstations.
  - 3. Fiber Characteristics: In accordance with requirements for fiber-optic cable.

- 4. Cable Configuration:
  - a. Individual tight-buffer thermoplastic, multimode or single-mode fibers, to match fibers being jumpered on.
  - b. Protected with Kevlar strength members and enclosed in thermoplastic jacket.
- 5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
- 6. Connectors:
  - a. As required by preceding paragraph, Connectors. Patch Panel: LC type.
  - b. On-axial Pull Strength: 33 N.
  - c. Normal-to-axial Pull Strength: 22 N.
- 7. Manufacturer: Corning.

## 2.07 CAT6 PATCH CABLE

- A. Unless the Owner decides otherwise, CAT6 patch cables and components shall be furnished by PICS.
- B. In accordance with Division 26, Electrical. Otherwise, furnish as specified below.
  - 1. Provide factory terminated and tested UTP patch cords in accordance with ANSI/TIA/EIA-568-B.
  - 2. Category 6 Modular Plug to Modular Plug: factory-assembled, eightposition modular plug-ended Category 6, four-pair 24 AWG stranded conductor UTP patch cord with straight-through wiring that shall be used between eight-position/eight-conductor modular patch panel ports to complete circuits.
  - 3. Backwards compatible to Category 3, 5, and 5e.
- C. Furnish and install CAT6 patch cables to connect Ethernet devices as shown on P&IDs.
- D. Provide six spare CAT6 patch cables at appropriate lengths.
- E. Manufacturer:
  - 1. Belden.
  - 2. Black Box.
  - 3. Hitachi.
  - 4. "Or-equal."

### 2.08 MECHANICAL SYSTEMS

A. Major mechanical systems are listed in Section 40 91 00, Instrumentation and Control Components.

## 2.09 ELECTRICAL REQUIREMENTS

- A. In accordance with Division 26, Electrical.
- B. Major electrical components and requirements are listed in Section 40 91 00, Instrumentation and Control Components, Electrical Requirements.

## 2.10 PANEL FABRICATION

- A. General:
  - 1. This section shall apply to all new panels. PICS shall supply the following control panels.
    - a. CP-30.
  - 2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
  - 3. Fabricate panel(s) and inner subpanels, install components and wire, and plumb at PICS' facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
  - 4. UL Listing Mark for New Panels and New Subpanels:
    - a. Mark stating "Listed Enclosed Industrial Control Panel" in accordance with UL 508A.
    - b. UL listing shall apply to each fabricated panel or subpanel, not just to the unfabricated enclosure itself.
    - c. Provide UL listing mark for each new panel and each new subpanel.
    - d. On panel or subpanel, fasten UL listing mark that includes a serial number unique to the panel. Include all required parameters, including but not limited to, the panel short circuit rating.
  - 5. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.
- B. Temperature Control:
  - 1. Freestanding Panels:
    - a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.
    - b. Ventilated Panels:
      - 1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel.
      - 2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
      - 3) For panels without backs against wall, furnish louvers on top and bottom of panel back.

- 4) Louver Construction: Stamped sheet metal.
- 5) Ventilation Fans:
  - a) Furnish where required to provide adequate cooling.
  - b) Create positive internal pressure within panel.
  - c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
- 6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
- c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
- 2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
- 3. Space Heaters:
  - a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
  - b. Refer to Control Panel Schedule in Article Supplements.
- C. Freestanding Panel Construction:
  - 1. Materials: Sheet steel, unless otherwise shown on the Drawings with minimum thickness of 10-gauge, unless otherwise noted.
  - 2. Panel Fronts:
    - a. Fabricated from a single piece of sheet steel, unless otherwise shown on the Drawings.
    - b. No seams or bolt heads visible when viewed from front.
    - c. Panel Cutouts: Smoothly finished with rounded edges.
    - d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
  - 3. Internal Framework:
    - a. Structural steel for instrument support and panel bracing.
    - b. Permit panel lifting without racking or distortion.
  - 4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
  - 5. Adjacent Panels: Securely bolted together so front faces are parallel.
  - 6. Doors:
    - a. Full height, fully gasketed access doors where shown on the Drawings.
    - b. Latches: Three-point, Southco Type 44.
    - c. Handles: "D" ring, foldable type.
    - d. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
    - e. Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.
    - f. Front and Side Access Doors: As shown on the Drawings.

- D. Nonfreestanding Panel Construction:
  - 1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
    - a. Panels listed as inside, air conditioned:
      - 1) Enclosure Type: NEMA 12.
      - 2) Materials: Steel.
    - b. Other Panels:
      - 1) Enclosure Type: NEMA 4X.
      - 2) Materials: Type 316 stainless steel.
  - 2. Metal Thickness: 14-gauge, minimum.
  - 3. Doors:
    - a. Rubber-gasketed with continuous hinge.
    - b. Stainless steel lockable quick-release clamps.
  - 4. Manufacturers:
    - a. Hoffman Engineering Co.
    - b. H. F. Cox.
- E. Panel Pocket:
  - For each panel, including each new panel provide a pocket that shall be installed within the panel. Preferred location is the inner front door. Pocket shall be suitable for storing a hard copy of the 11-inch by 17-inch panel wiring diagrams.
  - 2. Manufacturer and Product: Pocket shall be Hoffman, "Or-equal."
- F. Breather and Drains:
  - 1. Furnish with NEMA 250, Type 4 and 4X panels:
  - 2. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1 N4D, Breather Model ECD1 N4B.
- G. Solar shields and Rain hoods:
  - 1. Furnish with outdoor panels exposed to direct sunlight and rainfall.
  - 2. Panel shall be installed facing North.
- H. Control Panel Electrical:
  - 1. Power Distribution within Panels:
    - a. Feeder Circuits:
      - 1) One or more 120V ac, 60-Hz feeder circuits as shown on the Drawings.
      - 2) Make provisions for feeder circuit conduit entry.
      - 3) Furnish terminal block for termination of wires.

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- b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
  - 1) Locate to provide clear view of and access to breakers when door is open.
  - 2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
    a) Branch Circuit Breakers: 15 amps at 250V ac.
  - 3) Provide UL 489 listed breakers.
  - 4) Breaker Manufacturers and Products:
    - a) Square D; Multi 9 Series.
    - b) Allen-Bradley; 1489-A Series.
    - c) "Or-equal."
- c. Circuit Wiring: P&IDs and control diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
  - 1) Devices on Single Circuit: 20, maximum.
  - 2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
  - 3) Branch Circuit Loading: 12 amperes continuous, maximum.
  - 4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
  - 5) Provide 120V ac plugmold for panel components with line cords.
- 2. Signal Distribution:
  - a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
  - b. Outside Panels: Isolated 4 to 20 mA dc only.
  - c. Signal Wiring: Twisted shielded pairs.
  - d. RTD and Thermocouple Extension Cable:
    - 1) Continuous field to panel with no intermediate junction boxes or terminations.
    - 2) RTDs in motor windings are considered a 600-volt circuit.
    - 3) Terminate thermocouple extension wire directly to loop instrument.
- 3. Signal Switching:
  - a. Use dry circuit type relays or switches.
  - b. No interruption of 4 to 20 mA loops during switching.
  - c. Switching Transients in Associated Signal Circuit:
    - 1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
      - 2) 1V dc to 5V dc Signals: 0.05V, maximum.
- 4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Requirements.
- 5. Push-to-test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

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- 6. Internal Panel Lights for Freestanding Panels:
  - a. Type: Switched light-emitting diode (LED), equivalent to 100watt incandescent, back-of-panel lights.
  - b. Quantity: One light for every 4 feet of panel width.
  - c. Mounting: Inside and in the top of back-of-panel area.
  - d. Protective metal shield for lights.
- 7. Service Outlets for Freestanding Panels:
  - a. Type: Three-wire, 120 volt, 15 ampere, GFCI duplex receptacles.
  - b. Quantity:
    - 1) Panels 4 Feet Wide and Smaller: One.
    - 2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
  - c. Mounting: Evenly spaced along back-of-panel area.
- 8. Internal Panel Lights and Service Outlets for Smaller Panels:
  - a. Internal Panel Light: Switched light-emitting diode (LED), equivalent to 100 watt incandescent, light.
  - b. Service Outlet: Breaker protected 120 volt, 15 amp, GFCI duplex receptacle.
  - c. Required for panels. Refer to Control Panel Schedule in Article Supplements.
- 9. Standard Pushbutton Colors and Inscriptions:
  - a. Use following unless otherwise noted in individual Loop Descriptions.

Tag	Inscription(s)	Color
00	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

- b. Lettering Color:
  - 1) Black on white and yellow buttons.
  - 2) White on black, red and green buttons.
- 10. Standard Light Colors and Inscriptions:
  - a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in individual Loop Descriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

b. Lettering Color:

1) Black on white and amber lenses.

- 2) White on red and green lenses
- I. PIC Enclosure Internal Wiring:
  - 1. Restrain by plastic ties or ducts or metal raceways.
  - 2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
  - 3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
  - 4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
  - 5. Connections to Screw Type Terminals:
    - a. Locking-fork-tongue or ring-tongue lugs.
    - b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
    - c. Wires terminated in a crimp lug, maximum of one.
    - d. Lugs installed on a screw terminal, maximum of two.

- 6. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
- 7. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
- 8. For each analog circuit, provide an inline fuse.
- 9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
- 10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
- 11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
- 12. Conductor Color-coding:

Description	Color	
120V ac power line	Black	
120V ac power neutral	White	
Ground	Green	
120V ac power control	Red	
24V ac power/control	Orange/Black	
24V dc (+)	Orange	
24V dc (-)	Brown	
DC (+15V or less)	Purple	
DC (-15V or less)	Gray	
Foreign	Yellow	

a. Others in accordance with Division 26, Electrical.

- 13. Conductors Carrying Foreign Voltages within a Panel:
  - a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
  - b. Use wire with yellow insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with yellow insulation for any other purpose.
- 14. Harness Wiring:
  - a. 120V ac: No. 14 AWG, MTW.
  - b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
- 15. Panelwork:
  - a. No exposed connections.
  - b. Allow adjustments to equipment to be made without exposing these terminals.
  - c. For power and control wiring operating above 80V ac or dc, use covered channels or EMT raceways separate from low voltage signal circuits.

- 16. Plastic Wire Ducts Color:
  - a. 120V ac: White.
  - b. 24V dc: Gray.
  - c. Communications Cables and Fiber-optic Jumpers: Orange.
- 17. Provide a communications plastic wire duct for communications cables and fiber-optic cables between communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of communications cable.
- 18. Make plastic wire ducts the same depth.
- 19. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.
- J. Control Relay Arrangement and Temperature Rating:
  - 1. As shown on the Drawings.
  - 2. Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels.
  - 3. Control relays in panels located outdoors shall have an operating temperature rating of at least 130 degrees F. As a minimum, this includes: None.
- K. Factory Finishing:
  - 1. Furnish materials and equipment with manufacturer's standard finish system.
  - 2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
  - 3. Stainless Steel (Type 316): Painted white.
  - 4. Stainless Steel (Type 304): White powder-coated finish.
  - 5. Nonmetallic Panels: Not painted.
  - 6. Aluminum Panels: Not painted.
  - 7. Steel Panels:
    - a. Sand panel and remove mill scale, rust, grease, and oil.
    - b. Fill imperfections and sand smooth.
    - c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
    - d. Sand surfaces lightly between coats.
    - e. Dry Film Thickness: 3 mils, minimum.
    - f. Color: Gray.

#### 2.11 NAMEPLATES AND TAGS

- A. Panel Nameplates: Enclosure identification located on the enclosure face.
  - 1. Location and Inscription: Centered on panel door near top.

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- 2. Materials: Laminated plastic attached to panel with stainless steel screws.
- 3. Letters: 1/2-inch high, white on black background, unless otherwise noted.
- B. Component Nameplates—Panel Face: Component identification located on panel face under or near component.
  - 1. Location and Inscription: As shown.
  - 2. Materials: Adhesive-backed laminated plastic.
  - 3. Letters: 3/16-inch high, white on black background, unless otherwise noted.
- C. Component Nameplates—Subpanel: Component identification located on or near component and on subpanel.
  - 1. Inscription: Component tag number.
  - 2. Materials: Adhesive-backed, laminated plastic.
  - 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- D. Legend Plates for Panel-mounted Pushbuttons, Lights, and Switches.
  - 1. Inscription: Refer to:
    - a. Table under paragraph Standard Pushbutton Colors and Inscriptions.
    - b. Table under paragraph Standard Light Colors and Inscriptions.
  - 2. Materials: Laminated plastic, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
  - 3. Letters: Black on white background.
- E. Service Legends: Component identification nameplate located on face of component.
  - 1. Inscription: As shown.
  - 2. Materials: Adhesive-backed, laminated plastic.
  - 3. Letters: 3/16-inch high, black on white background.
- F. Nametags: Component identification for field devices.
  - 1. Inscription: Component tag number.
  - 2. Materials: 16-gauge, Type 304 stainless steel.
  - 3. Letters: 3/16-inch high, imposed.
  - 4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

#### SWF BAF IMPROVEMENTS

#### 2.12 CORROSION PROTECTION

- A. Areas Where Required: Refer to Part 3, Article Protection.
- B. Panels: Furnish and install in each new panel.
- C. Manufacturers and Products:
  - 1. Northern Instruments; Model Zerust VC.
  - 2. Hoffmann Engineering; Model A-HCI.

#### 2.13 SOURCE QUALITY CONTROL

- A. General:
  - 1. Engineer may actively participate in many of the tests.
  - 2. Engineer reserves right to test or retest specified functions.
  - 3. Engineer's decision will be final regarding acceptability and completeness of testing.
  - 4. Procedures, Forms, and Checklists:
    - a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
    - b. Describe each test item to be performed.
    - c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
  - 5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
  - 6. Conducting Tests:
    - a. Provide special testing materials and equipment.
    - b. Wherever possible, perform tests using actual process variables, equipment, and data.
    - c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
    - d. Define simulation techniques in test procedures.
    - e. Test Format: Cause and effect.
      - 1) Person conducting test initiates an input (cause).
      - 2) Specific test requirement is satisfied if correct result (effect), occurs.
    - f. For PIC systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.
- B. Unwitnessed Factory Test:
  - 1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
  - 2. Location: PIC System Integrator's facility.

- 3. Integrated Test:
  - a. Interconnect and test PIC, except for primary elements and smaller panels.
  - b. Exercise and test functions.
  - c. Provide stand-alone testing of smaller panels.
  - d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.
- C. Factory Demonstration Tests (FDT):
  - 1. Notify Engineer of test schedule 4 weeks prior to start of test.
  - 2. Scope:
    - a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
    - b. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
  - 3. Location: PIC System Integrator's facility.
  - 4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
    - a. Simulate each discrete signal at terminal strip.
    - b. Simulate correctness of each analog signal using current source.
  - 5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
  - 6. Operation of communications between the PLC system, single loop controllers (SLC).
  - 7. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
    - a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
    - b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
    - c. All required and shown functions for 25 percent of loops.
  - 8. Nonloop-Specific Functions:
    - a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
    - b. Timing: Include tests for timing requirements.
    - c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
  - 9. Correct deficiencies found and complete prior to shipment to Site.

- 10. Failed Tests:
  - a. Repeat and witnessed by Engineer.
  - b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
- 11. Make following documentation available to Engineer at test site both before and during FDT:
  - a. Drawings, Specifications, Addenda, and Change Orders.
  - b. Master copy of FDT procedures.
  - c. List of equipment to be tested including make, model, and serial number.
  - d. Approved hardware Shop Drawings for equipment being tested.
  - e. Approved preliminary software documentation Submittal.
- 12. Daily Schedule for FDT:
  - a. Begin each day with meeting to review day's test schedule.
  - b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

## PART 3 EXECUTION

- 3.01 EXAMINATION
  - A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:
    - 1. Proper installation.
    - 2. Calibration and adjustment of positioners and I/P transducers.
    - 3. Correct control action.
    - 4. Switch settings and dead bands.
    - 5. Opening and closing speeds and travel stops.
    - 6. Input and output signals.

## 3.02 INSTALLATION

- A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.
- B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.
- C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.
- D. Mechanical Systems:
  - 1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
- 2. Plastic Tubing Support: Except as shown on the Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
- 3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
- 4. Tubing and Conduit Bends:
  - a. Tool-formed without flattening, and of same radius.
  - b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
  - c. Slope instrument connection tubing in accordance with installation details.
  - d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
  - e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
  - f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
  - g. Blow debris from inside of tubing.
  - h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
  - i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
  - j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
  - k. Provide separate support for components in tubing runs.
  - 1. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
  - m. Keep tubing and conduit runs at least 12 inches from hot pipes.
  - n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
  - o. Securely attach tubing raceways to building structural members.
- 5. Enclosure Lifting Rings: Remove rings following installation and plug holes.
- E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

### SWF BAF IMPROVEMENTS

- F. Sequencing for Process Control Programming and System Integration: This Project will require modifications made to a live, active control system and SCADA system. Proper sequencing and coordination of installation and integration activities shall be required to ensure minimal disruptions are made to plant operations. The following describes, in general, the sequence, coordination, and schedule required for this Project. PICS shall develop and submit a sequencing plan for the following requirements as defined in Section 1.05 B., Action Submittals. Plans shall be reviewed for approval by Owner and Engineer prior to commencing integration activities.
  - 1. PICS shall coordinate installation and Field and Panel wiring of new control panels, new instruments, and SCADA system components with Owner, plant operations, and Engineer.
  - 2. PICS shall coordinate the installation of all new fiber cabling and fiber loops as shown on P&IDs. Proper coordination with plant operations shall be required to disconnect existing fiber connections and minimize disruption to plant operations.

# 3.03 FIELD QUALITY CONTROL

- A. General:
  - 1. Coordinate PIC testing with Owner and affected Subcontractors.
  - 2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
  - 3. Engineer may actively participate in tests.
  - 4. Engineer reserves right to test or retest specified functions.
  - 5. Engineer's decision will be final regarding acceptability and completeness of testing.
- B. Onsite Supervision:
  - 1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
  - 2. Require PIC site representative to supervise and coordinate onsite PIC activities.
  - 3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.
- C. Leak Tests: During preparation for testing, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.
- D. Testing Sequence:
  - 1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.

- 2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.
- 3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
- 4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.
- E. Testing:
  - 1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.
  - 2. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation
    - a. Loop/Component Inspections and Tests:
      - 1) These inspections and tests do not require witnessing.
      - 2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
      - 3) Provide space on forms for signoff by PIC System Integrator.
      - 4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
        - a) Project name.
        - b) Loop number.
        - c) Tag number for each component.
        - d) Checkoffs/Signoffs for Each Component:
          - (1) Tag/identification.
          - (2) Installation.
          - (3) Termination wiring.
          - (4) Termination tubing.
          - (5) Calibration/adjustment.
        - e) Checkoffs/Signoffs for the Loop:
          - (1) Panel interface terminations.
          - (2) I/O interface terminations with PLCs.
        - f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
        - g) Total loop operational.
        - h) Space for comments.
      - 5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs I/O module and include the following:
        - a) Project name.

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- b) Loop number.
- c) Component tag number or I/O module number.
- d) Component code number for I&C elements.
- e) Manufacturer for I&C elements.
- f) Model number/serial number for I&C elements.
- g) Summary of Functional Requirements; For Example:
  - (1) Indicators and recorders, scale and chart ranges.
  - (2) Transmitters/converters, input and output ranges.
  - (3) Computing elements' function.
  - (4) Controllers, action (direct/reverse) and control modes (P, I, D).
  - (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
  - (6) I/O Modules: Input or output.
- h) Calibrations, for example, but not limited to:
  - Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
  - (2) Discrete Devices: Actual trip points and reset points.
  - (3) Controllers: Mode settings (P&ID).
  - (4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
  - (5) Space for comments.
- b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
- c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
- d. FDT-Repeat:
  - 1) Repeat FDT onsite with installed PIC equipment and software.
  - 2) As listed in PIC subsections, certain portions of FDT may not require retesting.
  - 3) Use FDT test procedures as basis for this test.
  - 4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.
- e. Forms: Contractor and PIC System Integrator shall develop forms for the Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment. Examples can be provided by Engineer upon request.

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- 3. Functional Test:
  - a. Scope: Confirm PIC, including applications software, is ready for operation.
  - b. Refer to PIC subsections for additional requirements.
  - c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
- 4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.
- F. Performance Test During and After Facility Startup:
  - 1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
  - 2. Loop-specific and nonloop-specific tests same as required for SSDT except that entire installed PIC tested using actual process variables and functions demonstrated.
  - 3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
  - 4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
  - 5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
  - 6. Make O&M data available to Engineer at Site both before and during testing.
  - 7. Follow daily schedule required for SSDT.
  - 8. Determination of Ready for Operation: When Functional Test has been completed.
  - 9. Refer to examples of Performance Test procedures and forms in Article Supplements.

# 3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: As required by each PIC subsection.

B. Specialty Equipment: For certain components or systems provided under this section, but not manufactured by PIC System Integrator, such as magnetic flowmeters, provide services of qualified manufacturer's representative during installation, startup, demonstration testing, and training.

### 3.05 TRAINING

- A. General:
  - 1. Provide an integrated training program for Owner's personnel.
  - 2. Perform training to meet specific needs of Owner's personnel.
  - 3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
  - 4. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
  - 5. Owner reserves the right to reuse videotapes of training sessions.
- B. Management Seminar:
  - 1. Length: 2 days.
  - 2. Location: Owner's facility.
  - 3. Objective: Provide overview for nonoperations and maintenance personnel for understanding the PIC.
  - 4. Attended by management, engineering, and other nonoperations and nonmaintenance personnel.
  - 5. Primary Topics:
    - a. PIC Overview: How hardware and software are used for operation and control of facilities.
    - b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
    - c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
    - d. Management-oriented explanation of data management displays and printouts.
    - e. Walk-through of installed systems.
- C. Operations and Maintenance Training:
  - 1. General:
    - a. Refer to specific requirements specified in PIC Subsections.
    - b. Include review of O&M data and survey of spares, expendables, and test equipment.
    - c. Use equipment similar to that provided.
    - d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.

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- 2. Operations Training: For Owner's operations personnel on operation of I&C components.
  - a. Training Session Duration: Two instructor days.
  - b. Number of Training Sessions: Two.
  - c. Location: Project Site.
  - d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
  - e. Content: Conduct training on loop-by-loop basis.
    - 1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
    - 2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
    - 3) Interfaces with PIC subsystems.
- 3. Maintenance Training:
  - a. Training Session Duration: Two instructor days.
  - b. Number of Training Sessions: Two.
  - c. Location: Project Site.
  - d. Course Objective: Develop skills needed for routine maintenance of PIC.
  - e. Content: Provide training for each type of component and function provided.
    - 1) Loop Functions: Understanding details of each loop and how they function.
    - 2) Component calibration.
    - 3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
    - 4) Troubleshooting and diagnosis for equipment and software.
    - 5) Replacing lamps, chart paper, and fuses.
    - 6) I&C components removal and replacement.
    - 7) Periodic preventive maintenance.

### 3.06 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

### 3.07 PROTECTION

- A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.
- B. Periodically replace capsules based on capsule manufacturer's recommendations.

### SWF BAF IMPROVEMENTS

### 3.08 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are part of this Specification.
  - 1. Control Panel Schedule.
  - 2. PLC Input and Output List.
  - 3. Instrument List.
  - 4. Loop Specifications.
  - 5. Plant VTScada Sample Information.

# **END OF SECTION**

Panel	P&ID	Service	NEMA	Material	Maximum External Dimensions HxWxD (in)	Notes	FDT	Space Heater	Service Lights/Outlets	Environment	Solar Shield/ Rainhood
CP-30	08-N-602	HORIZONTAL PRESSURE FILTER SCADA PANEL	4X	Painted White Steel 316 SST	72x36x24	Freestanding with Floor Mounts or Pedestals, capable of being attached to rack for additional stability	Yes	NO	YES	Outside	YES

PLC-30 I/O LIST												
	DI = DIGITAL INPUT											
	DO = DIGITAL OUTPUT											
	AI = ANALOG INPUT											
AO = ANALOG OUTPUT												
ETH = ETHERNET COMMUNICATION *												
								ETH	ETH	ETH	ETH	
DWG	Tag	Equipment Description	I/O Function	DI	DO	AI	AO	DI	DO	AI	AO	
08-N-601	VFD-30-131	LAKE TRANSFER PUMP NO. 1	In Remote Status	1				1				
08-N-601	VFD-30-131	LAKE TRANSFER PUMP NO. 1	Speed Feedback			1				1		
08-N-601	VFD-30-131	LAKE TRANSFER PUMP NO. 1	Speed Command				1				1	
08-N-601	VFD-30-131	LAKE TRANSFER PUMP NO. 1	Run Status	1				1				
08-N-601	VFD-30-131	LAKE TRANSFER PUMP NO. 1	Run Command		1				1			
08-N-601	VFD-30-131	LAKE TRANSFER PUMP NO. 1	Fault Status	1				1				
08-N-602	PIT-30-152	FILTER INFLUENT PRESSURE	Pressure Reading			1						
08-N-602	PIT-30-154	FILTER EFFLUENT PRESSURE	Pressure Reading			1						
08-N-605	P-30-121	BACKWASH PUMP	In Remote Status	1				1				
08-N-605	P-30-121	BACKWASH PUMP	Run Status	1				1				
08-N-605	P-30-121	BACKWASH PUMP	Run Command		1				1			
08-N-605	P-30-121	BACKWASH PUMP	Fault Status	1				1				
08-N-605	FCV-30-121	BACKWASH PUMP CONTROL VALVE	In Remote Status	1								
08-N-605	FCV-30-121	BACKWASH PUMP CONTROL VALVE	Position Status			1						
08-N-605	FCV-30-121	BACKWASH PUMP CONTROL VALVE	Position Command				1				1	
08-N-605	FIT-30-121	BACKWASH PUMP FLOW METER	Flow Reading			1						
08-N-606	BLW-30-100	AIR SCOUR BLOWER	In Remote Status	1								
08-N-606	BLW-30-100	AIR SCOUR BLOWER	Run Status	1								
08-N-606	BLW-30-100	AIR SCOUR BLOWER	Run Command		1							
08-N-606	BLW-30-100	AIR SCOUR BLOWER	Fault Status	1								
N/A	CP-30	UPS FOR HORIZONTAL PRESSURE FILTER SCADA PANEL	Panel Door Intrusion Status	1								
N/A	CP-30	UPS FOR HORIZONTAL PRESSURE FILTER SCADA PANEL	UPS Battery OK	1								
N/A	CP-30	UPS FOR HORIZONTAL PRESSURE FILTER SCADA PANEL	UPS on Utility	1			1	1	1			
N/A	CP-30	UPS FOR HORIZONTAL PRESSURE FILTER SCADA PANEL	UPS Fail Status	1								
			I/O Totals	14	3	5	2	6	2	1	1	<u>34</u>

\* I/O COMMUNICATED OVER ETHERNET IS SECONDARY TO HARD-WIRED SIGNALS. CONTROL LOGIC SHALL BE DEVELOPED AROUND HARD-WIRED SIGNALS WITH ETHERNET COMMUNICATED SIGNALS AS BACKUP.

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INSTRUMENT LIST							
TAG NO	ISA CODE	COMP_CODE	OPTIONS	P+ID NO			
PIT-30-152	PE/PIT	P9	Range: 0-15 PSIG	08-N-601			
PIT-30-154	PIT-30-154 PE/PIT P9		Range: 0-15 PSIG	08-N-601			
FIT-30-121	121     FE/FIT     F4     Output: 155-2000 GPM		08-N-605				

# LOOP DESCRIPTIONS

- A. General:
  - 1. Abbreviations: as defined in Section 40 90 00, Instrumentation and Control for Process Systems.
  - 2. Process Instrumentations and Controls Supplier (PICS) shall coordinate with Owner to obtain software configuration standards for Programmable Logic Controllers (PLC) and Human Machine Interface (HMI) programming. Where not defined, use the following definitions and standards for PLC and HMI programming of the Loop Specifications.
  - 3. The following standard function blocks specify the standard PLC/HMI functions block to be developed and used to implement the PLC/HMI requirements specified in the Loop Specifications.
    - a. Discrete HMI/PLC Mode Command and Feed Back Status: When the HMI commands the PLC to specific mode such as Auto or Manual, the HMI shall be configured with an Auto write command database point and a in Auto mode database status.
    - b. Analog HMI/PLC Read-Write Process: When an analog value such as setpoint or controller output is specified to be accessible to the operator, the HMI shall be configured to write to the PLC register through one database tag and then read back the variable written to the PLC through a second database tag.
    - c. Discrete Equipment Control:
      - Controlled equipment to have ON-OFF-REMOTE (HOR) switch or a LOCAL/COMPUTER switch REMOTE/COMPUTER input to the PLC. The Controlled equipment shall include ON running status. PLC outputs include a RUN signal (or separate START and STOP signals) to start the equipment. The Applications Software shall prevent Start/Stop control of equipment by the PLC unless the HOR switch is in the REMOTE (COMPUTER) position.
      - 2) When the controlled Equipment is in REMOTE or COMPUTER the HMI and PLC shall be enabled to set the Equipment mode to HMI AUTO or HMI MANUAL. When the controlled Equipment is in HMI Manual the HMI and PLC shall be configured to Start and Stop the Equipment from the HMI. When the Controlled Equipment is in HMI Auto the automatic PLC routine shall control the ON/OFF status of the Equipment.
      - 3) Monitor the ON status of equipment in the REMOTE or COMPUTER mode. If the PLC calls for the equipment to RUN and does not receive an ON signal after a suitable time delay, lock out the equipment in the PLC and generate an alarm to the HMI.

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- 4) If the equipment is not in REMOTE or COMPUTER mode the logic shall set the mode Manual.
- 5) Equipment Available Statues: Provide equipment available status that is logically true when equipment is in REMOTE, HMI AUTO and not FAILED.
- 6) If the PLC calls for the equipment not to RUN (STOP) and the ON signal is true after a suitable time delay, lock out the equipment in the PLC and generate equipment failure alarm to the HMI.
- 7) The equipment failure alarm condition and the equipment lock out shall be cleared by the loss of the REMOTE signal or HMI initiated Reset.
- 8) Provide a test input that to be used for system testing. When the TEST input is true the RUN (or START/STOP) output shall be prohibited from energizing. When in this mode, the ON status points read by the HMI and used by the PLC logic will follow the command to run, instead of the field ON inputs.
- 9) Provide a bumpless transfer from LOCAL to REMOTE or COMPUTER mode. If the Pump is running in the LOCAL mode it shall continue running when transferred to REMOTE or COMPUTER.
- d. Lead/Standby Pump Control:
  - 1) The lead/standby provides control over two redundant pumps.
  - 2) The lead pump can run continuously or when called to run.
  - 3) The lag pump runs when the lead pump is not available or is not ON.
  - 4) Provide a FAIL output that goes true if there is no sequence selected or no pumps are available.
  - 5) Provide a 1-2 and 2-1 lead/lag sequence selection from the HMI.
- e. Discrete Valve (or Gate) Control:
  - Controlled valves have OPEN-CLOSED-REMOTE (OCR) switches with OPEN, CLOSED and REMOTE inputs to the PLC. PLC outputs include an OPEN signal (or separate OPEN and CLOSE signals) to open the valve. The applications software shall prevent control of valve by the PLC unless the OCR switch is in the REMOTE (COMPUTER) position.
  - 2) Equipment Available Statues: Provide equipment available status that is logically true when equipment is in REMOTE, HMI AUTO and not FAILED.

LOOP SPECIFICATIONS 40 90 00 SUPPLEMENT 4 - 2

- 3) When the controlled valve is in REMOTE the HMI and PLC shall be configured to set the valve mode to HMI AUTO or HMI MANUAL. When the controlled valve is in HMI Manual the HMI and PLC shall be configured to Open and Close the valve from the HMI. When the Controlled valve is in HMI Auto the automatic PLC routine shall control the Open/Close position of the valve.
- 4) Monitor the OPEN/CLOSED status of valve in the REMOTE position. If the HMI/PLC calls for the valve to OPEN and does not receive an OPEN signal after a suitable time delay, lock out the valve in the PLC and generate an alarm to the HMI.
- 5) If the PLC calls for the valve to CLOSE and continues to receive an OPEN signal or does not receive a CLOSED signal after a suitable time delay. Generate a valve failed alarm to the HMI.
- 6) The alarm condition and the valve shall be cleared when the valve is noted to be in the correct position.
- 7) Provide a test input that to be used for System Testing. When the TEST input is true the OPEN (or OPEN/CLOSE) output shall be prohibited from energizing. When in this mode, the OPEN/CLOSE status points read by the HMI and used by the PLC logic will follow the command to OPEN/CLOSE, instead of the field OPEN/CLOSE inputs.
- f. Analog Inputs:
  - Provide sample times for analog inputs of no slower than one sample every 2 seconds. For inputs that are used for control purposes, use sample times no slower than once every 1 second.
  - 2) Provide a first order digital filter on all analog inputs. Use the PLCs built-in lag filter and set the time constants to no greater than four times the input sample time.
  - 3) All analog inputs shall be configured into a floating point variable and scaled in engineering units.
  - 4) Provide analog switches on each analog input. Analog switches to provide High and Low alarms, or as shown or as described in the loop specifications. The setpoints for the analog switches shall be accessible and changeable through the HMI.
  - 5) Monitor signal failure (out of normal range) on all analog inputs and alarm on the HMI.

- g. Analog Switches:
  - All analog switches used for Process alarms, to START and STOP pumps, sequences, etc. shall be configured through analog switches. Two types of analog switches shall be provided one for rising signal and one for falling signal. Each analog switch shall be configured with a 1 percent dead band to prevent nuisance tripping. Provide operator access through the HMI to the analog switch setpoints.
  - 2) Each analog alarm shall be configured with four inputs and one output.
    - a) Inputs:
      - (1) Process variable scaled in engineering units.
      - (2) Setpoint.
      - (3) Minimum and Maximum engineering units.
    - b) Outputs: Discrete output that switches when the process variable is above or below the setpoint.
- h. Analog Control:
  - 1) Unless otherwise noted, controllers shall be configured as Proportional-Integral (PI) type. Unless specifically noted do not use derivative mode.
  - 2) Provide access through the HMI for discrete mode changes, Setpoint and controller output when the controller is in manual.
  - 3) Controller gain and integral time constant shall be adjusted to provide stable operation normal operating conditions.
  - 4) Use the position from of the PI equation unless otherwise noted.
  - 5) Freeze the controller bias to prevent reset wind up, if the output is out of range.
  - 6) Controller sample times shall be no slower than once every 2 seconds.
  - 7) Provide bumpless transfer between operating modes, Auto to manual, and manual to auto.
  - 8) Provide a HMI Controller tuning display for each loop. The tuning display shall have a trend that trends the Process Variable, Setpoint and Output.
  - 9) Provide a setpoint initialization routine that initializes the setpoint to the value of process variable when the loop in set to Automatic.
  - 10) Unless otherwise noted, the Analog control shall be one shot into Manual when signal failure is detected on the Process variable. Provide a HMI alarm that indicates that the loop was set to MANUAL.

- 11) Each Controller shall be configured with a Manual Loading Station that has the follow functions:
  - a) The Output of the Manual Loading Station to the Manipulated Device is input back to the PLC.
  - b) The Manual Loading Station also has a Remote Status that is input into the PLC.
- 12) When the Manual Loading Station in Not in Remote, the Loop Controller shall be forced into manual and the manual output shall track the input from the Manual Loading Station.
- 13) Indicate the Manual Loading Station Local/Remote Status on the HMI.
- i. Alarm Processing:
  - 1) Provide alarms as noted or shown.
  - 2) All alarms shall be configured into Alarm Areas as specified by the Owner in the Workshops.
  - 3) Discrete type alarms shall be provided with an adjustable delay timer so that they do not become nuisance alarms.
- j. Feed Forward Flow Pacing:
  - 1) The Feed Forward Flow.
  - 2) The Flow Ratio control routine shall be configured to calculate the chemical flow demand in GPM, based on a HMI entered Flow ratio in PPM and the flow that the chemical is to be ratioed to.
  - 3) The flow demand is passed to a scaling routine that calculates the desired pump flow based on the flow demand and operator entered calibration constant. The desired pump flow is scaled to 0 to 100 percent pump speed.
  - 4) The pump calibration constant is entered into the HMI and constitutes the pump flow at maximum flow.
  - 5) Totalize the flow based on the calculated flow demand when the pump ON status shows the pump is on. Display the flow total on the HMI.
- k. Manual Equipment Control from the PLC:
  - 1) Provide a HMI AUTO/MANUAL mode for PLC-controlled devices. In the HMI AUTO mode, the device shall operate as described in the Loop Specifications. In the HMI MANUAL mode, the operator shall control the device through Start/Stop or Open/Close commands from the HMI.
  - 2) The software AUTO/MANUAL selection shall be allowed only when the device's panel switch is in the REMOTE or COMPUTER position.
  - 3) Provide MANUAL mode start and stop capability on all equipment, valves, and packaged systems (devices) that are controlled from the PLC, unless otherwise noted.

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- 4) Receive a discrete variable from the HMI in the MANUAL mode, indicating that the device should start or stop (open or close).
- 5) When the device is in MANUAL, disable normal sequence of operations from controlling the device. Do not override shut-down interlocks.
- 1. Run-Time Counters:
  - 1) Provide a run-time counter for all motorized equipment that has an ON signal to the PLC.
  - 2) Accumulate run times in hours with a minimum resolution of 0.1 hour. Counters shall roll over automatically when the accumulator is full.
  - 3) Provide for a contact from the HMI to reset all run-time counters, on demand or by reaching a preset of 30,000 hours.
  - 4) Store all run-time counters in a linear block of PLC memory for transmission to the HMI.
- m. Sequences:
  - 1) All sequences shall be divided into individual steps and be a command report-back type sequence. For example, the PLC shall issue a command for a valve to open (or pump to start) and then it will monitor the valve limit switches (or motor starter auxiliary contact or flow switch) to verify that it did open (or pump start). If the correct feedback status is not received within a preset time limit an individual failed alarm shall be initiated.
  - 2) Once a sequence has been started, it shall advance from one step to the next when all of the previous steps commanded by the PLC have been verified by the "report-back" portion of the program.
  - 3) Each sequence shall have a systems level MANUAL/OFF/AUTOMATIC control from the HMI. In the OFF mode the sequence shall be reset to the home, step 0. In the manual mode the sequence shall be started by a HMI START/STOP control. In the AUTOMATIC mode the sequence shall be started by the specified automatic control functions.
  - 4) If in any sequence step, a device fails to respond to the control of the PLC the sequence shall stop and remain in the current step. The sequence shall remain in the failed step until the HMI start function is initiated. The sequence will then retest the current step and advance to the next step if the device has responded to the control action.

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- 5) Each sequence shall have a HMI JOG function. The JOG function shall advance the step by one, independent of the normal step advance conditionals and timers.
- 6) Each sequence shall transmit bit variable indicating the active step to the HMI.
- Totalization: All Flow, weight, and power signals shall be n. totalized in the PLC and the flow totals communicated to the HMI. All totalizers shall be calculated at least every 3 seconds. PLC special function programs shall be configured to scale the process variable to be totalized into gallons, pounds, or KWH in three seconds. These scaled variables shall be accumulated every 3 seconds until an accumulated value is greater than the unit digit value. When the accumulated value is greater than the unit digit value, a totalizing counter shall be incremented by one and the accumulated value subtracted from the unit digit value, and the accumulated value set equal to the result. A threshold detector shall be developed to inhibit the totalizer from totalizing until the process value is greater than a preset percentage of the scale range. Each totalizer shall reset to 0 at 30,000 counts or from a single reset coil shall reset all PLC totalizer counters. The reset coil shall be controlled by the HMI.
- o. Sampler Functions:
  - 1) Receive at the PLC a contact closure denoting trouble (TRBL) with the sampler. Store this contact state for use in the PLC and transmission to the HMI.
  - 2) When the sampler is required to start transmitting, a RUN contact closure from the PLC to panel. Store this contact state for use in PLC and transmission to the HMI.
  - 3) Provide Manual/Auto control of the sampler from the HMI. When the control is in the manual mode the sampler sequence shall be controlled through a start control. When the control is in the AUTO mode the sampler shall be controlled by either flow or time. In the Time mode the sampler shall be controlled by repeat cycle timer that is controlled and monitored through the HMI. In the flow mode the sampler shall be controlled by a flow totalizer. The flow totalizer shall be monitored and controlled through the HMI.
- p. Process Control Functions Timing:
  - 1) The objective of the process control function timing function is to reduce processor loading on any one scan by distributing over four time slots.
  - 2) Provide a timing sequence that is designed to distribute processing of functions in one of four time slots. The duration of each time slot shall be controlled to one scan, approximately 0.25 second.

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#### SWF BAF IMPROVEMENTS

- B. Unit Process Specific Control Descriptions:
  - 1. Each Unit Process's specific control loops are described in a contiguous section of text. These text sections are broken down into an Overview and Specifications. The Overview provides general information regarding control of the Unit Process, including functions of control systems other than the PIC System. The Specification section provides additional detail of the PIC system functions for each Unit Process. The Specification section is broken down into subsections titled Field and PLC/HMI. The PLC/HMI covers functions provided in Programmable Logic Controllers (PLC) and the Human Machine Interface (HMI) system. These descriptions assume that a device is ready to operate if the operator has placed the device into the REMOTE mode.

#### C. Unit Processes:

 Overview: This section describes the required control system modifications to integrate the biologically active filters (BAF) (M30-100 and M30-201-0), backwash water supply pump (P30-121) and air scour blower (BLW30-100) into the SWF and the City's SCADA and included changes to the lake transfer pump controls.

The BAF system shall have two operational modes, NORMAL and BACKUP FEED. During NORMAL operation the Lake Transfer Pump 1 (P30-131) speed will modulate to maintain an inputted BAF feed pressure. If using the BACKUP FEED mode the Raw Water Feed pumps (RW1 and RW2) will be operated based on an operator inputted pump speed. Flow through the filters in both modes will be controlled based on an operator inputted flow setpoint. The BAF filter filtrate FCVs (FCV30-110 and FCV30-210) will modulate to control the flow through operating filter(s). Individual BAF filtrate flow set points will be calculated by the BAF PLC (LCP-30-101) based on inputted flow setpoint divided by the number of operating BAFs.

The BAF control system supplied by the filter system supplier will communicate with the plant Supervisory Control and Data Acquisition (SCADA) system, transferring data from the filter system instrumentation and control system and status of the filters. The filter control system will primarily control the operation of the filter valves during changes in filter status and modulation and flow control using the plant SCADA system supplied flow setpoint and the filtrate flow meters (FIT30-110 and FIT30-210) and flow control valves (FCV30-110 and FCV30-210).

LOOP SPECIFICATIONS 40 90 00 SUPPLEMENT 4 - 8 Each filter vessel has a pressure differential instrument/transmitter that monitors the differential pressure of each pressure filter. An adjustable high and high-high differential pressure set point will be used to prevent operation of the individual pressure filters at a differential pressure greater than 15 psid. The high-high alarm will trigger an alarm and notification that the alarming filter should be backwashed as soon as possible.

- 2. Filter Flume Control and Filter flow Calculations:
  - a. Overview: the filter flume level control includes the calculation of individual filter (gravity and pressure) flow set points. These controls will be modified to incorporate the installed pressure filters with the operation of the gravity filters.
  - b. Field: Not applicable.
  - c. PLC/HMI:
    - 1) The pressure filters have a smaller media surface area than the gravity filters and consequently will have a different individual filter flow setpoint. The flow to each gravity and pressure filter will be calculated based on the number of "equivalent gravity filters" in operation. The plant PLC will calculate the number of equivalent gravity filters in service based on an adjustable (supervisor permission) pressure filter correction factor (PFCF) and the number of operational pressure and gravity filters. Each operating gravity filter will have a value of 1 equivalent gravity filter and each operating pressure filter will have an equivalent equal to the PFCF.

Equivalent Number of Operating Gravity Filters = Number of operating gravity filters + PFCF x Number of operating pressure filters.

The plant PLC will calculate the individual filter flow set by dividing the total flow setpoint by the number of equivalent operating filters. The filter flow control for each gravity filter will be equal to the calculated filter flow setpoint and each pressure filter flow control setpoint will be equal to the calculated filter flow.

Gravity Filter flow setpoint = Calculated filter flow setpoint Filter Vessel flow setpoint = calculated filter flow setpoint x VFCF.

The calculated pressure filter flow setpoint will transferred to the pressure filter control system PLC (programmed by the Filter System Supplier) that will control flow through each pressure filter using the filter effluent flow control valve.

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- 2) Plant PLC Control setpoints:
  - a) Allowable flume level setpoint is 1.0 to 3.3 ft.
  - b) Pressure Filter Operational Parameters (filter 7 through 10): These parameters will be controlled from the plant HMI and PLC and transferred to the pressure filter control PLC (as needed) supplied and programmed by the pressure filter system supplier. The filter vessels will have the following values to control each filters operation:
    - (1) The maximum surface loading rate through each filter is 4 gpm/ft<sup>2</sup> (0.00576 MGD/ft<sup>2</sup>) (can be reduced by supervisor).
    - (2) The maximum filter flow rate through each filter vessel will be based on the maximum surface loading rate and the media surface area (initially 480 ft<sup>2</sup>, adjustable by supervisor).
    - (3) The maximum rate of change for a running filter is approximately 1 gpm/ft<sup>2</sup> over a 30 minute period (can be adjusted by supervisor).
    - (4) The maximum flow through a single pressure filter is 2.75 MGD.
- 3. Lake Transfer Pump:
  - a. Overview: The lake transfer pump (P30-131) is provided with adjustable speed control. The pumps will be used to maintain an operator inputted pressure set point (supervisor) monitored by the pressure filter feed pressure indicator and transmitter (PIT30-152). The lake transfer pump will be monitored and controlled by the plant PLC. A low-low filter feed pressure or filtrate flow will initiate the shutdown of the operating pressure filters and lake transfer pump.
  - b. Field: Not applicable.
  - c. PLC/HMI:
    - 1) Filter feed pump pressure filter feed pressure:
      - a) High pressure alarm.
      - b) Low pressure alarm.
      - c) Low-low discharge: Plant PLC will send shutdown all pressure filter signal to pressure filter system PLC and shut down operating filter feed pump after preset time.
    - 2) Filtrate flow rate:
      - a) Low flow alarm (adjustable setpoint).
      - b) Low-low flow alarm (adjustable setpoint): Plant PLC will send shutdown all pressure filter signal to pressure filter system PLC and shut down operating lake transfer pump.

LOOP SPECIFICATIONS 40 90 00 SUPPLEMENT 4 - 10

- 3) Filter feed pump start up interlocks:
  - a) After pump start if the low filter feed pressure alarm does not clear after an inputted time (adjustable by supervisor to be set during startup) the SCADA system will alarm and the lake transfer pump will shut down.
- 4. Filters:
  - a. Overview: The BAF's function is to biologically treat raw water to minimize it's fouling potential on downstream processes. Although the BAFs should remain in continuous operation they are not required to be operational for downstream process operations.

The filters will operate based on an inputted flow setpoint with the flow distributed between the operating filters. The flow through each filter will be controlled by each operating filters filtrate flow control valve modulating to control flow based on the filtrate flow meter.

The maximum flow through each filter is 6.4 gpm/ft<sup>2</sup> (3,100). The maximum rate of change for a running filter is approximately 5 gpm/ft<sup>2</sup> (adjustable setpoint).

- 1) Each filter will have six operational modes:
  - a) Out of service.
  - b) Startup.
  - c) Filtration.
  - d) Prepare for backwash.
  - e) Backwash.
  - f) Standby.
- 2) Pressure Filter System Controls:
  - a) The pressure filter system supplier shall be responsible for the programming of the pressure filter control system described in Section 46 61 01, Horizontal Pressure Filter. The pressure filter system supplier shall coordinate with the ASP and ensure all required and specified information is transferred to and from the pressure filter control system. The control system shall be programmed in accordance with Section 40 90 00, Instrumentation and Control for Process Systems and its supplements and as described herein.

- b) All data or information associated with the pressure filter system instrumentation and equipment that is shown in the Drawings and as specified to transfer data to the pressure filter system PLC shall be passed to the plant PLC for integration into the plant SCADA system. This includes pressure filter system valve position and status, and individual pressure filter status.
  - (1) The equipment associated with an individual pressure filter and directly controlled by the pressure filter control panel (LCP-30-101) includes:
    - (a) Cell A and B Influent isolation valves (FV30-X01 and X02, X=1,2).
    - (b) Cell A and B filtrate/backwash supply isolation valves (FV30-X05 and X06, X=1,2).
    - (c) Cell A and B air scour supply isolation valves (FV30-X07 and X08, X=1,2).
    - (d) Filtrate flow control valve (FCV30-X10, X-1,2).
    - (e) Filtrate to ground storage tank isolation valve (FCV30-X11, X-1,2).
    - (f) Cell A and B backwash drain isolation valves (FV30-X03 and X04, X=1,2).
    - (g) Filter backwash supply isolation valve (FCV30-X09, X-1,2).
    - (h) Filter drain valve (FCV30-X12, X-1,2).
    - (i) Filtrate flow meter (FIT30-X10, X-1,2).
    - (j) Filter differential pressure instrument (PDIT30-X01, X-1,2).
  - (2) Common equipment used to operate the pressure filters that are directly controlled by the plant SCADA control panel (CP30-1) include:
    - (a) Backwash supply pump (P30-101).
    - (b) Backwash supply flow control valve (FV30-121) and flow meter (FIT30-121).
    - (c) Air scour blower (BLW30-100).
    - (d) Lake transfer pump 1 (P30-131).
    - (e) Raw water pumps 1 and 2 (RW-1 and RW-2).
    - (f) Filter feed pressure (PIT30-154).
- b. Field: The pressure filters will only be operated via the plant and pressure filter system PLCs.

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- c. PLC/HMI:
  - 1) Pressure Filter System Alarms:
    - a) Pressure filter system alarms will be modified and monitored by the plant PLC (PCP). The pressure filter system PLC (PFLCP) shall monitor and transfer the instrumentation values included in the pressure filter system to the plant PLC.
    - b) Pressure Filter Alarms:
      - (1) Individual filter Differential Pressure:
        - (a) Shall not exceed 15.0 psid.
        - (b) Adjustable High differential pressure alarm will: Trigger alarm.
        - (c) Adjustable High-High differential pressure alarm: Trigger alarm and initiate popup window indicating backwash is required with operator selection of:
          - i) Continue operation.
          - ii) Commence backwash.
      - (2) Pressure Filter Effluent Flow:
        - (a) Low flow alarm will occur if the pressure filter effluent flow meter is XX percent (adjustable) below the pressure filter flow setpoint for an adjustable amount of time.
        - (b) Low low flow alarm will occur if the pressure filter effluent flow meter is XX percent (adjustable) below the pressure filter flow setpoint for an adjustable amount of time and trigger filter shutdown. If new calculated filter flow setpoint exceeds operating filter maximum flow the flow setpoint will be reduced to the maximum flow setpoint and operator notified of change.
        - (c) High flow alarm will occur if the pressure filter effluent flow is XX percent (adjustable) above the pressure filter flow setpoint for an adjustable amount of time.
  - 2) Plant and pressure filter system PLC communications:
    - a) From plant PLC to pressure filter system PLC:
      - (1) Call to start pressure filter, system or individual filters.
      - (2) Call to perform backwash of selected pressure filter.
      - (3) Status of selected pressure filter.

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- (4) Call to shutdown pressure filter, individual or all.
- (5) Pressure system filter flow setpoint.
- b) From pressure filter system PLC to plant PLC:
  - (1) Individual pressure filter:
    - (a) Flow.
    - (b) Differential pressure.
    - (2) Individual filter status.
    - (3) Sequence completion during:
      - (a) Startup.
        - (b) Backwash
        - (c) Shutdown
    - (4) Actuated valves:
      - (a) Position.
      - (b) Faults.
      - (c) Status.
- 3) The general sequencing of the pressure filter operation shall be:
  - a) Verify system status:
    - (1) All Filter Devices in Auto.
    - (2) Lake transfer pump in Auto.
    - (3) No filter Analog with High High, Low Low interlock or faults.
    - (4) Common Equipment Assigned to enter Backwash and in Auto.
    - (5) Verify All valves in correct position.
  - b) Start filter or filter system:
    - PVLCP Open Cell A and B Influent isolation valves (FV30-X01 and X02, X=1,2) and filtrate/backwash supply isolation valves (FV30-X05 and X06, X=1,2) for selected filters.
    - (2) If starting up the system:
      - (a) When influent isolation valves are open PCP starts lake transfer pump 1 and ramp to inputted starting setpoint (adjustable) and PFLCP opens filtrate flow control valve (FCV30-X10, X-1,2) to preset position (adjustable).
      - (b) When filtrate flow (FIT30-X10, X-1,2) and filter feed pressure (PIT30-154) stabilizes place the lake transfer pump into automatic pressure control (PCP) and ramp flow up to flow setpoint (PVLCP).

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- (3) If the system is already running:
  - (a) PFLCP opens filtrate flow control valve (FCV30-X10, X-1,2) to preset position (adjustable).
  - (b) When filtrate flow setpoint is reached PVLCP place the filter filtrate control loop into automatic.
- (4) PVLCP change status of filter to Filtration
- 4) Pressure filter backwash:
  - a) Only one system filter (including gravity and pressure filters) can be backwashed at a time.
  - b) Normal backwashing includes air scouring of one pressure filter cell with a low-rate backwash flow.
  - c) Normal backwashing will include a high-rate backwash of one cell at a time.
  - d) Following setpoints will be adjustable with supervisory permissions:
    - (1) Backwash supply high flow and low flow rate.
    - (2) Filter drain time.
    - (3) Filter cell air scour time.
    - (4) Filter cell high backwash flow time.
    - (5) Filter rest time.
  - e) When operator selects backwash of filter commence backwash sequence:
    - (1) Verify system status:
      - (a) Backwash pump in Auto.
      - (b) Backwash flow control valve in auto
      - (c) If the filter system flow setpoint exceeds the maximum filter flow setpoint inform operator that the system flow setpoint exceeds the operating filter maximum flow, and provide the operator following:
        - i) Cancel backwash.
        - ii) Reduce flow setpoint to maximum operating filter system maximum flow.
      - (d) Increase flow setpoint for operating filter or startup additional filter and reduce flow rate for filter to be backwashed. When filter is operating with filtrate control loop in Auto at the required flow rate shut the filter to be backwashed filtrate control valve and Cell A and B Influent isolation valves (FV30-X01 and X02, X=1,2).

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- (2) Drain filter:
  - (a) PFLCP Open the Filter drain valve (FCV30-X12, X-1,2).
  - (b) After filter drain time is reached PFLCP shut Filter drain valve (FCV30-X12, X-1,2).
- (3) Air scour:
  - (a) PFLCP open filter backwash supply isolation valve (FCV30-X09, X-1,2) and Filtrate flow control valve (FCV30-X10, X-1,2).
  - (b) PFLCP open:
    - i) Cell A or B backwash drain isolation valve (FV30-X03 or X 04, X=1,2).
    - ii) Cell A or B filtrate/backwash supply isolation valve (FV30-X05 or X06, X=1,2).
  - (c) PCP open backwash supply flow control valve (FV30-121) to minimum position.
  - (d) PFLCP open Cell A or B air scour supply isolation valves (FV30-X07 or X08, X=1,2).
  - (e) PCP start air scour blower and backwash supply pump.
  - (f) Place backwash supply flow control valve (FV30-121) control loop in automatic and control flow (FIT30-121) to the low backwash flow setpoint.
  - (g) After air scour time has elapsed: PCP stop air scour blower and shut Cell A or B air scour supply isolation valves (FV30-X07 or X08, X=1,2).
  - (h) PCP increase backwash supply flow rate by changing flow setpoint to high flow backwash rate.
  - After high flow backwash time has been reached stop the backwash supply pump and shut the backwash supply flow control valve.
  - (j) PFLCP shut:
    - i) Cell A or B backwash drain isolation valve (FV30-X03 or X 04, X=1,2).

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- Cell A or B filtrate/backwash supply isolation valve (FV30-X05 or X06, X=1,2).
- (k) Repeat steps (3) (b) to (3)(k) to backwash Cell B (if not done).
- PFLCP shut filter backwash supply isolation valve (FCV30-X09, X-1,2) and Filtrate flow control valve (FCV30-X10, X-1,2).
- (m) After the backwash rest time has been reached PFLCP change status of filter to Standby.

# 5. SCADA HMI System:

- a. General Description: The SCADA HMI system for the plant is a VTScada software system, version 11.2.14. It is one of several nodes in the overall Marco Island VTScada system. Refer to 40 90 00 Supplement 5, Plant VTScada Sample Information for additional system descriptions and sample screens for reference.
- b. General Requirements: Develop and deploy new SCADA HMI screens to accomplish all functions, where noted, in the previous loop descriptions for the various processes.
- c. General Integration Work:
  - 1) All new HMI screens shall adhere to style standards currently used at CP-1's HMI client (i.e. color schemes, pop-ups, alarm handling, etc.). New HMI screens for the Horizontal Pressure Filter should match control capabilities and present similar information that is available on the LCP-30-101's OIT screens.
  - 2) Program HMI client at CP-30 as a new remote VTScada node. In addition to the new HMI screens to monitor and control the Horizontal Pressure Filters, Backwash Pump, and Air Scour Blower, this node shall have the same control, access, and screens as the HMI client at CP-1.
  - 3) Program HMI client at CP-1 with new HMI screens developed for CP-30's HMI client.
  - 4) Deploy changes to greater SCADA HMI system at remote plants and sites. Coordinate with Owner on locations and requirements.
- 6. PLC-1 Programming for Power Overload Warnings and Interlock
  - a. General Description: Due to the increased number of pumps (and equipment) at this plant as well as their power consumption, there is a potential to overload the plant's main transformer should all pumps (and equipment) be called to run. PLC-1 shall be programmed to monitor and alert for these conditions.

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- b. General Requirements: Coordinate a workshop with Owner and Engineer to discuss programming details of the interlock scheme.
- c. General Integration Work:
  - Monitor number of pumps (and equipment) running. Prevent additional pumps (and equipment) from running to prevent a power overload. This may require programming additional plant PLCs that control single processes.
  - Generate notification and alarms correlating to the number of pumps (and equipment) that is running. Program VTScada to accept these new notifications and alarms.

# Marco Island SWF BAF VTScada HMI System Sample Information

# System Description

# A. Overview

The human machine interface (HMI) system at Marco Island SWF BAF is a remote VTScada node of the greater VTScada HMI system for the entire municipal's SCADA system. The node is a panel-mounted industrial personal computer (PC) and can be found in the High Service Pumping Building as attached to CP-1. Currently, this node monitors and controls the raw water processes at the plant to include high service pumping and lake transfer pumping.

This document is intended to give the reader a brief overview of the system, components (hardware and software), and schemes. For additional details, a contractor should obtain the latest copy of the VTScada application and the Owner's published control system and HMI system standards, if available.

# B. Components

- 1. Software: VTScada v11.2.14 Premium Package, includes:
  - a. 25K points
  - b. Dual Server
  - c. Alarm Notification
- 2. Hardware: Advantech Panel-Mounted PC (PPC-4211W-P5AE) Windows 7.
- 3. Networking: Industrial Ethernet, Modbus TCP.

# Sample Screens

# A. General

The following screenshots are intended to give the reader a glimpse of the type of navigation and layout, color scheme(s), faceplates, alarm handling, etc. currently deployed with the Marco Island SWF BAF VTScada application.

In general, faceplates are used for all major equipment (i.e. pumps, valves, handswitches) and numerical interfaces are used for process and instrumentation values.

Green indicates "RUNNING/ON" status for equipment and Red indicates "NOT RUNNING/OFF". In the case of alarms, Green indicates "NORMAL" and Red indicates "IN ALARM"

Navigation is done through push buttons located on the left or right side of the HMI screen, whichever side can accommodate the Navigation Panel. The Alarm banner/list resides at the bottom of the HMI screens.

Sticky Notes are utilized to convey maintenance information about the equipment or system. Several examples of the utilization of Sticky Notes can be seen in the following screenshots.



🕞 🖲 🗸 Scada	NWTP Raw Water 2	😡 🗞 宿 記 日 🖶 🐥 1:42:28 PM January 6, 2023 M
<text></text>	No higher than 75% kick on 2 and pump per Social STOP RM STOP RM	Storage 9/2/19
2023-01-06     Lobal     Normal     IV/F     RVMFLEFMELLAN_ENK2_34(_3V, 4AM       2023-01-06     10-052-AM     Acs     Normal     IV/F     RVMFLEFMELLAN_ENK2_34(_3V, 4AM       2023-01-06     10-052-AM     Acs     Normal     IV/F     RVMFLEFMELLAN_ENK2_34(_3V, 4AM       2023-01-06     10-052-AM     Acs     Normal     IV/F     RVMFLEFMELLSCHAR_ENK3_57012       2023-01-06     0-054-3M     Acs     Normal     IV/F     RVMFLEFMELLSCHAR_ENK3_57012       2023-01-06     0-054-3M     Acs     Normal     IV/R     RVMFLEFMELLSCHAR_ENK3_57012       2023-01-06     0-054-3M     Acs     Normal     IV/R     RVMFLEFMELLSCHAR_ENK3_57012       2023-01-06     0-054-3M     Acs     Normal     IV/R     RVMFLEFMELLSCHAR_ENK3_57012       2023-01-06     0-052-3M     Aci     Normal     IV/R     RVMFLEFMELLSCHAR_ENK3_57012       2023-01-06     0-052-3M     Aci     Normal     IV/R     RVMFLEFMELLSCHAR_ENK3_5702       2023-01-06     SU127-AM     Aci     Normal     IV/R     System	FWP Retains (borgs Tack #2 high Levit Alam FWP MR1- Nex All Densets in Auto FWP MR1- Nex All Densets in Auto FWP MR1- Nex All Densets in Auto LS1 Lated - Surk Densets in Auto Surk 1984 & GOLD - Surk Denset Internet Feld Feld MR Feld	

### SECTION 40 91 00 INSTRUMENTATION AND CONTROL COMPONENTS

# PART 1 GENERAL

#### 1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

#### 1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. NSF International (NSF):
    - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
    - b. NSF/ANSI 372, Drinking Water System Components Lead Content.

### PART 2 PRODUCTS

- 2.01 GENERAL
  - A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists.
  - B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists.
  - C. All other Part 2 articles cover components that are referenced by Instrument Lists in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.
  - D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
    - 1. Use or reuse of components and materials without a traceable certification is prohibited.

### SWF BAF IMPROVEMENTS

### 2.02 MECHANICAL SYSTEMS

- A. Flow Element, Rotameter, Purge:
  - 1. For air service, unless otherwise noted.
  - 2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
  - 3. Direct-reading Scale Length: 2-1/2 inches, minimum.
  - 4. Scale Ranges: 0 to 2.5 scfh for air service or 0 to 10 gph for water service.
  - 5. Integral inlet needle valves.
  - 6. Integral Differential Pressure Regulators:
    - a. For water service.
    - b. For air service for level ranges greater than 10 feet of water.
  - 7. Manufacturers and Products:
    - a. Fischer & Porter; Series 10A3130.
    - b. Brooks; Series DS-1350.
- B. Manifold, Three-valve Equalizing:
  - 1. Type: For isolation and equalization of differential pressure transducers.
  - 2. Materials: Stainless steel.
  - 3. Manufacturers and Products:
    - a. Anderson, Greenwood and Co.; Type M1.
    - b. Evans.
- C. Pressure Gauge: For other than process variable measurement.
  - 1. Dial Size: Nominal 2-inch dial size.
  - 2. Accuracy: 2 percent of span.
  - 3. Scale Range: Such that normal operating pressure lies between 50 and 80 percent of scale range.
  - 4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
  - 5. Manufacturers and Products:
    - a. Ashcroft Utility; Gauge Series 1000.
    - b. Marsh; Standard Gauge Series.
    - c. Ametek U.S.; Gauge Series P500.
    - d. Acculite; Series 2000.
- D. Valve, Needle:
  - 1. Materials: Stainless Steel body with 0.020-inch orifice.
  - 2. Manufacturers and Products:
    - a. Whitey; Model 21RF2.
    - b. Hoke; 3700 Series.

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- E. ON/OFF Valves:
  - 1. Type: Ball valve.
  - 2. Materials: Stainless Steel.
  - 3. Manufacturers and Products:
    - a. Whitey; Series 41 through Series 43.
    - b. Hoke; Flomite 7100 Series.
- F. Regulating Valves:
  - 1. Type: Needle valves, with regulating stems and screwed bonnets.
  - 2. Materials: Stainless steel.
  - 3. Manufacturers and Products:
    - a. Whitey; Catalog No. RF or RS.
    - b. Hoke; 3100 through 3300 Series.
- G. Valve, Three-way:
  - 1. Type: Ball valve.
  - 2. Materials: Stainless steel with nylon handle.
  - 3. Manufacturers and Products:
    - a. Whitey; Series 41 through Series 43.
    - b. Hoke; Selecto-Mite Series.
- H. Valve, Four-way:
  - 1. Type: Four-way, two-position ball valve.
  - 2. Materials:
    - a. Body and Stem: Type 316 stainless steel.
      - b. Handle: Black nylon.
      - c. Packing Gland: Teflon.
  - 3. Ball and stem bed, one-piece assembly.
  - 4. Machined handle stops and directional nameplates.
  - 5. Manufacturers and Products:
    - a. Whitey; Series 457.
    - b. Hoke; Multi-Mite Series.
- I. Spool Valve:
  - 1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
  - 2. Materials: Aluminum construction with Teflon-impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
  - 3. Port Connection: 1/4-inch OD tube fittings.
  - 4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

- J. Solenoid Valve, Two-way:
  - 1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
  - 2. Materials:
    - a. Body: Brassed globe valves.
    - b. Valve Seat: Buna-N.
  - 3. Size: As noted and normally closed or opened, as noted.
  - 4. Coil: 115V ac, unless noted otherwise.
  - 5. Solenoid Enclosure: NEMA 4.
  - 6. Manufacturer and Product: ASCO; Red Hat Series 8260.
- K. Pressure Regulator, Air:
  - 1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 to 300 scfh with 100 psi supply pressure.
  - 2. Setscrew for outlet pressure adjustment.
  - 3. Integral filter and relief valve.
  - 4. Manufacturers and Products:
    - a. Masoneilan; Series 77-4.
    - b. Fisher; Series 67FR.
- L. Pressure Regulator, Water:
  - 1. Materials:
    - a. Body: Bronze.
    - b. Spring Case: Cast iron.
    - c. Seat Rings: Brass.
    - d. Valve Disk and Holder: Buna-N and bronze.
    - e. Diaphragm: Buna-N diaphragm.
  - 2. Sizing: For maximum of 7 psi offset pressure.
  - 3. Manufacturers and Products:
    - a. Fisher; Controls Type 95H or 95L.
    - b. Masoneilan; Series 17.
- M. Test Tap:
  - 1. Manufacturers and Products:
    - a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
    - b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
    - c. Parker; CPI Series precision quick couplings.

- N. Copper Tubing and Fittings:
  - 1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
  - 2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on the Drawings.
  - 3. Manufacturers and Products:
    - a. Parker-Hannifin.
    - b. Swagelok; tube fittings.
- O. Plastic Tubing and Fittings:
  - 1. Tubing: Polyethylene capable of withstanding 190 psig at 175 degrees F.
    - a. Manufacturers and Products:
      - 1) Dekoron; Type P.
      - 2) Imperial Eastman; Poly-Flo black instrument tubing.
  - 2. Fittings:
    - a. Type: Brass compression.
    - b. Manufacturers and Products:
      - 1) Imperial Eastman; Poly-Flo tube fittings.
      - 2) Dekoron; E-Z fittings.
- P. Stainless Steel Tubing: ASTM A312, Type 316, seamless, soft annealed, as shown on the Drawings, 0.065-inch wall.
- Q. Stainless Steel Fittings:
  - 1. Compression Type:
    - a. Materials: Stainless steel, ASTM A182 forged bodies or ASTM A276 barstock bodies, Type 316, flareless.
    - b. Manufacturers and Products:
      - 1) Parker Flodar; BA Series.
      - 2) Swagelok; tube fittings.
      - 3) Parker CPI; Parker A-LOK dual ferrule tube fittings.
  - 2. Socket Weld Type:
    - a. Materials: Stainless steel, ASTM A182 forged bodies or ASTM A276 barstock bodies, Type 316 for 3,000 psi maximum working pressure, safety factor 4:1.
    - b. Manufacturers:
      - 1) Cajon.
      - 2) Swagelok.
      - 3) Parker WELDLOK.

- R. Air Set: Consist of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.
- S. Purge Set:
  - 1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on the Drawings and as specified.
  - 2. Pressure Gauge Scale Range: 150 percent of the process variable.
  - 3. Mounting: Within consoles, panels, or a separate enclosure as shown.
- T. Tubing Raceways:
  - 1. Cable tray systems complete with tees, elbows, reducers, and covers.
  - 2. Size in accordance with manufacturer's recommendations for the intended service.
  - 3. Materials: Aluminum.
  - 4. Manufacturers:
    - a. Globetray.
    - b. Cope.
- U. Air Supply Sets:
  - 1. Parts, Integrally Mounted:
    - a. Pressure Controls: Automatic START/STOP, factory set at 30 to 50 psig.
    - b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
    - c. Pressure gauge.
    - d. Inlet filter muffler.
    - e. Power: 120V ac.
    - f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
    - g. Manufacturers and Products:
      - 1) ITT Pneumotive; GH Series.
      - 2) Gast.
  - 2. Simplex Air Supply Sets:
    - a. Air Receiver: 2 gallons.
    - b. Compressors: One.
  - 3. Duplex Air Supply Sets:
    - a. Air Receiver: 20-gallon.
    - b. Compressors: Two.
    - c. Automatic Failover Control: Factory set at 20 psig.

# 2.03 ELECTRICAL REQUIREMENTS

- A. Terminal Blocks for Enclosures:
  - 1. General:
    - a. Connection Type: Screw compression clamp.
    - b. Compression Clamp:
      - 1) Complies with DIN-VDE 0611.
      - 2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      - 3) Guides strands of wire into terminal.
    - c. Provide a 35 mm DIN rail-mounted plastic drawer to hold spare fuses.
    - d. Screws: Hardened steel, captive, and self-locking.
    - e. Current Bar: Copper or treated brass.
    - f. Insulation:
      - 1) Thermoplastic rated for minus 55 to 110 degrees C.
      - 2) Two funneled shaped inputs to facilitate wire entry.
    - g. Mounting:
      - 1) Standard DIN rail.
      - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      - 3) End Stops: Minimum of one at each end of rail.
    - h. Wire Preparation: Stripping only permitted.
    - i. Jumpers: Allow jumper installation without loss of space on terminal or rail.
    - j. Marking System:
      - 1) Use wire numbers to identify terminals.
      - 2) Terminal number shown on both sides of terminal block.
      - 3) Allow use of preprinted and field marked tags.
      - 4) Terminal strip numbers shown on end stops.
      - 5) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams. Use wire numbers to identify terminals.
      - 6) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
    - k. Test Plugs: Soldered connections for 18 AWG wire.
      - 1) Pin Diameter: 0.079 inch.
        - 2) Manufacturers and Products:
          - a) Entrelec; Type FC2.
          - b) Weidmuller.
          - c) Allen-Bradley.
          - d) Phoenix Contact.

- 2. Terminal Block, General-purpose:
  - a. Rated Voltage: 600V ac.
  - b. Rated Current: 30 amps.
  - c. Wire Size: 24 AWG to 10 AWG.
  - d. Rated Wire Size: 10 AWG.
  - e. Color: Gray body.
  - f. Spacing: 0.25 inch, maximum.
  - g. Test Sockets: One screw test socket 0.079-inch diameter.
  - h. Manufacturers and Products:
    - 1) Entrelec; Type M4/6.T.
      - 2) Weidmuller.
      - 3) Allen-Bradley.
      - 4) Phoenix Contact.
- 3. Terminal Block, Ground:
  - a. Wire Size: 24 AWG to 10 AWG.
  - b. Rated Wire Size: 10 AWG.
  - c. Color: Green and yellow body.
  - d. Spacing: 0.25 inch, maximum.
  - e. Grounding: Electrically grounded to mounting rail.
  - f. Manufacturers and Products:
    - 1) Entrelec; Type M4/6.P.
    - 2) Weidmuller.
    - 3) Allen-Bradley.
    - 4) Phoenix Contact.
- 4. Terminal Block, Blade Disconnect Switch:
  - a. Rated Voltage: 600V ac.
  - b. Rated Current: 10 amps.
  - c. Wire Size: 22 AWG to 10 AWG.
  - d. Rated Wire Size: 10 AWG.
  - e. Color: Gray body, orange switch.
  - f. Spacing: 0.25 inch, maximum.
  - g. Manufacturers and Products:
    - 1) Entrelec; Type M4/6.SNT.
    - 2) Weidmuller.
    - 3) Allen-Bradley.
    - 4) Phoenix Contact.
- 5. Terminal Block Diode:
  - a. Rated Voltage: 24V dc.
  - b. Rated Current: 30 ma.
  - c. Wire Size: 16 AWG.
  - d. Manufacturers and Products:
    - 1) Phoenix Contact; ST-IN.
    - 2) Weidmuller.
    - 3) Allen-Bradley.
    - 4) Phoenix Contact.

- 6. Terminal Block, Fused, 24V dc:
  - a. Rated Voltage: 600V dc.
  - b. Rated Current: 25 amps.
  - c. Wire Size: 22 AWG to 10 AWG.
  - d. Rated Wire Size: 10 AWG.
  - e. Color: Gray body.
  - f. Fuse: 0.25 inch by 1.25 inches.
  - g. Indication: LED diode 24V dc.
  - h. Spacing: 0.512 inch, maximum.
  - i. Manufacturers and Products:
    - 1) Entrelec; Type ML10/13.SFD.
    - 2) Weidmuller.
    - 3) Allen-Bradley.
    - 4) Phoenix Contact.
- 7. Terminal Block, Fused, 120V ac:
  - a. Rated Voltage: 600V ac.
  - b. Rated Current: 25 amps.
  - c. Wire Size: 22 AWG to 10 AWG.
  - d. Rated Wire Size: 10 AWG.
  - e. Color: Gray body.
  - f. Fuse: 0.25 inch by 1.25 inches.
  - g. Indication: Neon lamp, 110V ac.
  - h. Leakage Current: 1.8 mA, maximum.
  - i. Spacing: 0.512 inch, maximum.
  - j. Manufacturers and Products:
    - 1) Entrelec; Type ML10/13.SFL.
    - 2) Weidmuller.
    - 3) Allen-Bradley.
    - 4) Phoenix Contact.
- 8. Terminal Block, Fused, 120V ac, High Current:
  - a. Rated Voltage: 600V ac.
  - b. Rated Current: 35 amps.
  - c. Wire Size: 18 AWG to 8 AWG.
  - d. Rated Wire Size: 8 AWG.
  - e. Color: Gray.
  - f. Fuse: 13/32 inch by 1.5 inches.
  - g. Spacing: 0.95 inch, maximum.
  - h. Manufacturers and Products:
    - 1) Entrelec; Type MB10/24.SF.
    - 2) Weidmuller.
    - 3) Allen-Bradley.
    - 4) Phoenix Contact.

- B. Relays:
  - 1. General:
    - a. Relay Mounting: Plug-in type socket.
    - b. Relay Enclosure: Furnish dust cover.
    - c. Socket Type: Screw terminal interface with wiring.
    - d. Socket Mounting: Rail.
    - e. Provide holddown clips.
    - f. Interposing relays are not required on spare discrete outputs.
  - 2. Signal Switching Relay:
    - a. Type: Dry circuit.
    - b. Contact Arrangement: 2 Form C contacts.
    - c. Contact Rating: 5 amps at 28V dc or 120V ac.
    - d. Contact Material: Gold or silver.
    - e. Coil Voltage: As noted or shown.
    - f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
    - g. Expected Mechanical Life: 10,000,000 operations.
    - h. Expected Electrical Life at Rated Load: 100,000 operations.
    - i. Indication Type: Neon or LED indicator lamp.
    - j. Seal Type: Hermetically sealed case.
    - k. Manufacturers and Products:
      - 1) Potter and Brumfield; Series KH/KHA.
      - 2) Idec.
      - 3) Allen-Bradley.
  - 3. Control Circuit Switching Relay, Nonlatching:
    - a. Type: Compact general-purpose plug-in.
    - b. Contact Arrangement: 3 Form C contacts.
    - c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
    - d. Contact Material: Silver cadmium oxide alloy.
    - e. Coil Voltage: As noted or shown.
    - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
    - g. Expected Mechanical Life: 10,000,000 operations.
    - h. Expected Electrical Life at Rated Load: 100,000 operations.
    - i. Indication Type: Neon or LED indicator lamp.
    - j. Push-to-test button.
    - k. Gold flashed contacts.
    - 1. Manufacturers and Products:
      - 1) Potter and Brumfield; Series KUP or KRPA.
        - 2) Idec.
        - 3) Allen-Bradley.
  - 4. Control Circuit Switching Relay, Latching:
    - a. Type: Dual coil mechanical latching relay.
    - b. Contact Arrangement: Two Form C contacts.
    - c. Contact Rating: 10A at 28V dc or 120V ac.
    - d. Contact Material: Silver cadmium oxide alloy.

- e. Coil Voltage: As noted or shown.
- f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
- g. Expected Mechanical Life: 500,000 operations.
- h. Expected Electrical Life at Rated Load: 50,000 operations.
- i. Manufacturers and Products:
  - 1) Potter and Brumfield; Series KB/KBP.
  - 2) Idec.
  - 3) Allen-Bradley.
- 5. Control Circuit Switching Relay, Time Delay:
  - a. Type: Adjustable time delay relay.
  - b. Contact Arrangement: 2 Form C contacts.
  - c. Contact Rating: 10A at 30V dc or 277V ac.
  - d. Contact Material: Silver cadmium oxide alloy.
  - e. Coil Voltage: As noted or shown.
  - f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
  - g. Repeatability: Plus or minus 2 percent.
  - h. Delay Time Range: Select range such that time delay setpoint falls between 20 percent to 80 percent of range.
  - i. Time Delay Setpoint: As noted or shown.
  - j. Mode of Operation: As noted or shown.
  - k. Adjustment Type: Integral potentiometer with knob external to dust cover.
  - l. Manufacturers and Products:
    - Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.
    - 2) Idec.
    - 3) Tyco/Agastat.
- C. Wires within Enclosures:
  - 1. ac Circuits:
    - a. Type: 600-volt, Type MTW stranded copper.
    - b. Size: For current to be carried, but not less than No. 18 AWG.
  - 2. Analog Signal Circuits:
    - a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
    - b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Belden No. 1121A.
    - c. Size: No. 18 AWG, minimum.
  - 3. Other dc Circuits:
    - a. Type: 600-volt, Type MTW stranded copper.
    - b. Size: For current carried, but not less than No. 18 AWG.
  - 4. Special Signal Circuits: Use manufacturer's standard cables.

- D. Wires entering or leaving enclosures, terminate and identify as follows:
  - 1. Wire Identification:
    - a. Numbered and tagged at each termination on the terminal block and on wire.
      - 1) Use wire numbers to identify terminals.
      - 2) Number shall include the tag number of the associated field instrument.
    - b. Wire Tags: Machine printed, heat-shrink.
    - c. Manufacturers and Products:
      - 1) Brady; Perma Sleev.
      - 2) Tyco Electronics.
  - 2. Special signals terminated using manufacturer's standard connectors.
  - 3. Identify wiring in accordance with Division 26, Electrical.
- E. Wiring External to PIC Equipment:
  - 1. Special Control and Communications Cable: Provided by PICS as noted in Component Specifications and PIC subsections.
- F. Analog Signal Isolators:
  - 1. General:
    - a. Function: Isolate an analog current signal.
    - b. Type:
      - 1) Solid state with external power supply.
      - 2) Three-way isolation of the input signal, output signal, and external power supply.
  - 2. Performance:
    - a. Isolation:
      - Three-way isolation between input, output, and power circuits for common mode voltages up to 250V ac, or 354V dc of ground, on a continuous basis.
      - 2) Able to withstand 1,500V ac dielectric strength test for 60 seconds without breakdown.
    - b. Output Ripple: Less than plus or minus 0.1 percent of maximum output span.
    - c. Accuracy: Plus or minus 0.1 percent of output span.
    - d. Ambient Temperature, Operating: Minus 13 degrees F to 149 degrees F.
  - 3. Features:
    - a. Zero and span trim adjustments using 15-turn potentiometers.
    - b. Calibration independent of load.
    - c. Compact dimensions with width less than or equal to 6.2 mm.
    - d. Power supply possible through foot element.

- 4. Signal Interface:
  - a. Input:
    - 1) 4 mA to 20 mA dc.
    - 2) Impedance: 50 ohms.
  - b. Output:
    - 1) 4 mA to 20 mA dc.
    - 2) Drives output load impedance up to 500 ohms independent of supply voltage to isolator.
- 5. Enclosure:
  - a. NEMA 1, unless otherwise noted.
  - b. Mounting: DIN rail, unless otherwise noted.
- 6. Power: 24V dc.
- 7. Manufacturers:
  - a. Phoenix Contact MINI MCR.
  - b. Weidmuller.
- G. Analog Signal Splitter:
  - 1. General:
    - a. Function: Split and isolate an analog input current signal into two identical isolated analog output current signals.
    - b. Type:
      - 1) Solid state with external power supply.
      - 2) Four-way isolation of the input signal, output signals, and external power supply.
      - Parts: Signal splitter.
  - 2. Performance:

c.

- a. Isolation:
  - Four-way isolation between input, output 1, output 2, and power circuits for common mode voltages up to 250V ac, or 354V dc off ground, on a continuous basis.
  - 2) Able to withstand 1,500V ac dielectric strength test for 60 seconds without breakdown.
- b. Output Ripple: Less than plus or minus 0.1 percent of maximum output span.
- c. Accuracy: Plus or minus 0.1 percent of output span.
- d. RFI Resistance: 10V/meter at frequencies of 80 to 1,000 MHz AM and 900 MHz keyed carrier, in accordance with EN61000-4-3 and ENV50204.
- e. EMI resistance: Less than plus or minus 0.25 percent of output span effect under the influence of electromagnetic fields from switching solenoids or commutator motors and drill motors.
- f. Ambient Temperature, Operating: Minus 13 to 167 degrees F.

- 3. Features:
  - a. Two 15-turn potentiometers, Zero and span, per output channel, accessible from front of unit.
  - b. Calibration independent of load.
- 4. Signal Interface:
  - a. Input:
    - 1) 4 to 20mA dc.
    - 2) Impedance: 150 ohms at full scale.
  - b. Output:
    - 1) 4 to 20 mA dc each channel.
    - 2) Drives output load impedance up to 950 ohms.
- 5. Enclosure:
  - a. NEMA 1, unless otherwise noted.
  - b. Mounting: DIN Rail, unless otherwise noted.
- 6. Power: 24V dc, unless otherwise noted.
- 7. Manufacturers and Products:
  - a. Acromag; Model 633T-0100.
  - b. Action; I/Q Q404-4.
  - c. Phoenix Contact; MCR-2-UNI-UI-2UI (Part No.: 2905026).
- H. Grounding of Enclosures:
  - 1. Furnish isolated copper grounding bus for signal and shield ground connections.
  - 2. Ground this ground bus at a common signal ground point in accordance with NEC requirements.
  - 3. Single-point Ground for Each Analog Loop:
    - a. Locate signal ground at dc power supply for loop.
    - b. Use to ground wire shields for loop.
    - c. Ground signal shields to the ground bus using conductors.
  - 4. Ground terminal block rails to ground bus.
  - 5. Ground the subpanel to the ground bus using a single conductor.
  - 6. Ground surge suppressors to the DIN rail, which is grounded to the subpanel by screws.
- I. Hand Switch, Light, and Pushbutton, Corrosion-resistant, Round:
  - 1. General:
    - a. Function: Select, initiate, and display discrete control functions.
    - b. Type: Heavy-duty, corrosion-resistant, industrial.
  - 2. General Features:
    - a. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.

- b. Legend Plate: Standard size, square style laminate with white field and black markings, unless otherwise noted. Markings as shown on the Drawings.
- c. Configuration: Light, pushbutton, or switch as noted or shown.
- 3. Light Features:
  - a. Lights: Universal LED lamps for operation from 12 to 120V ac/dc, unless otherwise noted.
  - b. Lens Color: Color as specified, noted, or shown.
  - c. Push-to-test, unless otherwise noted.
  - d. Additional: As noted.
- 4. Pushbutton Features:
  - a. Operator: Single pushbutton, flush, unless otherwise noted.
  - b. Color: Black, unless otherwise noted.
  - c. Boot: None, unless otherwise noted.
  - d. Contact Arrangement: As required or shown.
  - e. Finger safe guard.
  - f. Additional: As noted.
- 5. Selector Switch Features:
  - a. Operator: Knob, unless otherwise noted.
  - b. Color: Black, unless otherwise noted.
  - c. Boot: None, unless otherwise noted.
  - d. Positions: As required or shown.
  - e. Return: Manual, unless otherwise noted.
  - f. Contact Arrangement: As required or shown.
  - g. Additional: As noted.
- 6. Signal Interface:
  - a. Contact Block:
    - 1) Type: Standard, unless otherwise noted.
    - 2) Materials: Silver amalgam, unless otherwise noted.
    - 3) Rating: 10 amps continuous at 120V ac, unless otherwise noted.
    - 4) Sequence: Break-before-make, unless otherwise noted or shown.
    - 5) Arrangement: Normally open or normally closed as shown, or to perform the functions noted.
- 7. NEMA Rating: NEMA 4, watertight, dust-tight, and NEMA 4X, corrosion-resistant.
- 8. Manufacturers and Products:
  - a. Allen-Bradley; Bulletin 800H.
  - b. Square D Co.; Class 9001, Type SK.

- J. Intrinsic Safety Barriers:
  - 1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
    - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
  - 2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
    - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
- K. Surge Suppressors:
  - 1. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices. Provide as shown on the Drawings and as specified below.
  - 2. Suppressor Locations:
    - a. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
    - b. On analog pairs at each end when the pair travels outside of building.
    - c. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.
  - 3. Suppressor Design:
    - a. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
    - b. Response: 5 nanoseconds maximum.
    - c. Recovery: Automatic.
    - d. Temperature Range: Minus 20 to 85 degrees C.
    - e. Enclosure-mounted: Encapsulated in flame-retardant epoxy.
  - 4. Suppressors on 120V ac Power Supply Connections:
    - a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
    - b. First-stage Clamping Voltage: 350 volts or less.
    - c. Second-stage Clamping Voltage: 210 volts or less.
    - d. Power Supplies for Continuous Operation:
      - 1) Four-wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
      - 2) All Other Applications: Minimum 30 amps at 130V ac.
  - 5. Suppressors on Analog Signal Lines:
    - a. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.

- b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
  - 1) dc Clamping Voltage: 20 to 40 percent above operating voltage for circuit.
  - 2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
  - 3) Maximum Loop Resistance: 18 ohms per conductor.
- 6. Suppressor Types:
  - a. SS1 is for 120V power line mounted in panel interior.
  - b. SS2 is for 4 to 20 mA signal wire mounted in panel interior.
  - c. SS3 is for a single, field-mounted analog signal.
  - d. SS4 is 120V power line and 4 to 20 mA signal wire, field-mounted.
- 7. Manufacturers and Products:
  - a. Mounted in Enclosures: Encapsulated in flame-retardant epoxy.
  - b. 120V ac Lines:
    - 1) Emerson Edco; HSP-121.
    - 2) Phoenix Contact MAINS-Plugtrab.
  - c. Analog Signals Lines:
    - 1) Emerson Edco; PC-642 or SRA-64 series.
    - 2) Phoenix Contact Plugtrab 2X2.
  - d. Field-mounted at Two-wire Instruments:
    - 1) Encapsulated in stainless steel pipe nipples.
    - 2) Emerson Edco; SS64 series.
  - e. Field-mounted at Four-wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
    - 1) Enclosure:
      - a) NEMA 4X Type 316 stainless steel with door.
      - b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
    - 2) Emerson Edco; SLAC series.
  - f. 480-volt, Three-phase Power Supplies: Square D; Model SDSA3650.
- 8. Grounding:
  - a. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26 05 26, Grounding and Bonding for Electrical Systems and suppressor manufacturer's requirements.
  - b. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.
- 9. Provide 20 percent or no less than two analog surge suppressors for each panel spare analog I/Os.

- L. Power Supplies:
  - 1. Furnish as required to power panel components and instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs.
  - 2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
  - 3. Provide output over voltage and over current protective devices to:
    - a. Protect instruments from damage due to power supply failure.
    - b. Protect power supply from damage due to external failure.
  - 4. Enclosures: NEMA 1/IP20.
  - 5. UL 508 Listed.
  - 6. Mount such that dissipated heat does not adversely affect other components.
  - 7. Fuses:
    - a. Purpose:
      - 1) For each dc supply line to each individual two-wire transmitter.
      - 2) For each dc branch circuit.
    - b. Type: Indicating.
    - c. Mount so fuses can be easily seen and replaced.
  - 8. Amperage Rating: 5 amps, unless otherwise noted.
  - 9. If two power supplies with redundancy module are shown on the Contract Drawings, connect to provide redundant operation. Refer to the Contract Drawings for power distribution for each panel.
  - 10. Manufacturers and Products:
    - a. Power Supply: Phoenix Contact; Part 2904600.
    - b. Redundancy Module: Phoenix Contact; Part 2320173 with DIN Rail Adapter Part 2320089.
- M. Network Interface Panel:
  - 1. Provide secure place inside control panel to terminate fiber optic cable.
  - 2. Compartments: Two; one for fiber optic cables, one for jumpers to individual equipment.
  - 3. Coil Former: Former to wind slack cable around, provides controlled long radius bends.
  - 4. Connectors: Minimum 4 LC style multimode pigtail connectors for entry and exit.
    - a. Use for splicing pre-terminated pigtails to field cables.
    - b. Pigtail Strands: 6.
    - c. Pigtail Length: 3 meters.
  - 5. Each individual fiber shall be color coded in accordance with TIA/EIA-598.

- 6. Mountings: Suitable for permanent attachment including wall stand-off brackets.
- 7. Cable Strain Relief: Provide strain relief for each fiber cable.
- 8. Splice Tray:
  - a. Securely organize and provide physical protection without stress on fibers for both single-mode and multimode individual and ribbonized fiber splices.
  - b. Accommodate fusion splice, fusion splice with heat-shrink sleeve or mechanical sleeve, and mechanical splice part.
  - c. High-precision molded construction that holds and protects actual splice thus eliminating need for extra splice protection parts.
  - d. Provide positive holding action for maximum splice protection during installation and operation.
- 9. Manufacturers and Products:
  - a. Corning Cable Systems, Single Panel Housing.
  - b. DINSpace, SNAP Compact Fiber Optic Patch Panel.

## 2.04 I&C COMPONENTS

- A. Components for Each Loop: Major components for each loop are listed in Section 40 90 00, Supplement 3, Instrument List. Furnish all equipment that is necessary to achieve required loop performance.
- B. Component Specifications: Generalized specifications for each type of component are listed.
- D. F4 Flow Element and Transmitter, Electromagnetic:
  - 1. General:
    - a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
    - b. Type:
      - 1) Electromagnetic flowmeter, with operation based on Faraday's Law, using the pulsed dc type coil excitation principle with high-impedance electrodes.
      - 2) Full bore meter with magnetic field traversing entire flow-tube cross section.
      - 3) Unacceptable are insert magmeters or multiple single-point probes inserted into a spool piece.
    - c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
  - 2. Service:
    - a. Stream Fluid:
      - 1) As shown on P&IDs.

- Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
- b. Flow Stream Descriptions: If and as described below.
- 3. Operating Temperature:
  - a. Element:
    - 1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
    - 2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
  - b. Transmitter:
    - 1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
    - 2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.
- 4. Performance:
  - a. Flow Range: 0-2000 GPM.
  - b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
  - c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
- 5. Features:
  - a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
  - b. No obstructions to flow.
  - c. Very low pressure loss.
  - d. Measures bi-directional flow.
- 6. Process Connection:
  - a. Meter Size (diameter inches): 16 inches.
  - b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
  - c. Flange Material: Carbon steel, unless otherwise noted.
- 7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
- 8. Element:
  - a. Meter Tube Material: Type 316 stainless steel, unless otherwise noted.
  - b. Liner Material:
    - 1) Teflon, unless otherwise noted.
    - 2) For potable water service, must have appropriate approvals.
  - c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
  - d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.

- e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
- f. Grounding Ring:
  - 1) Required, unless otherwise noted.
  - 2) Quantity: Two, unless otherwise noted.
  - 3) Material: Type 316 stainless steel, unless otherwise noted.
- g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
- h. Submergence:
  - 1) Temporary: If noted.
  - 2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
- i. Direct-buried (3 to 10 feet): If noted.
- j. Hazardous Area Certification:
  - 1) Class 1, Division 2, Groups A, B, C, D: If noted.
  - 2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
  - 3) Class 1, Division 1, Groups C, D, and FM approved: If noted.
- 9. Transmitter:
  - a. Mounting: Surface (wall), unless otherwise noted.
  - b. Display: Required, unless otherwise noted.
    - 1) Digital LCD display, indicating flow rate and total.
    - 2) Bi-directional Flow Display: Required, unless otherwise noted.
      - a) Forward and reverse flow rate.
      - b) Forward, reverse and net totalization.
  - c. Parameter Adjustments: By keypad or non-intrusive means.
  - d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
  - e. Empty Pipe Detection:
    - 1) If noted.
    - 2) Drives display and outputs to zero when empty pipe detected.
- 10. Signal Interface (at Transmitter):
  - a. Analog Output:
    - 1) Isolated 4 to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
    - 2) Supports Superimposed Digital HART protocol: If noted.
  - b. Discrete Outputs: If noted.
    - 1) Two discrete outputs, typical, rated for up to 30 volts, typical.
    - 2) Programmable as noted for the following typical parameters: Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.

- c. Discrete Input: If noted.
  - 1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
- d. Other: As noted.
- 11. Cables:
  - a. Types: As recommended by manufacturer.
  - b. Lengths: As required to accommodate device locations.
- 12. Built-in Diagnostic System:
  - a. Features:
    - 1) Field-programmable electronics.
    - 2) Self-diagnostics with troubleshooting codes.
    - 3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
    - 4) Initial flow tube calibration and subsequent calibration checks.
- 13. Factory Calibration:
  - a. Calibrated in an ISO 9001 and NIST certified factory.
  - b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
  - c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
- 14. Factory Ready for Future In situ Verifications: If noted.
  - a. Original meter parameter values available from vendor by request.
- 15. Accessories:
  - a. In situ Verification System: If noted.
    - 1) Quantity: One complete system provided for the Project.
    - 2) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
    - 3) Physical access to the flow-tube not required.
    - 4) Meet standards established by the National Testing Laboratory.
    - 5) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
    - 6) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
    - 7) Windows-based software.
  - b. Primary Simulation System: If noted.
    - 1) Quantity: One complete system provided for the Project.

- 2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
  - a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
  - b) Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
  - c) Switch selectable for forward, reverse and zero flow rate.
- 3) Verifies various input and output signals.
- 16. Manufacturers and Products:
  - a. Emerson Process Management, Rosemount Division:
    - 1) Model 8705 (flanged) and Model 8711(wafer) flow tubes.
    - 2) Model 8712 (surface) and Model 8732 (integral) transmitters.
  - b. Endress & Hauser, Inc. Flow-measuring System, Promag 50/53P (size, 1/2 to 24 inches).
  - c. McCrometer: Ultra-Mag (size, 2 to 48 inches).
- E. F16 Flow Element, Rotameter:
  - 1. General:
    - a. Function: Indicate flow rate.
    - b. Type: Variable area; float and tapered tube.
  - 2. Service Conditions:
    - a. Process Fluid: Water, unless otherwise noted.
    - b. Temperature Range:
      - 1) Process Fluid: 33 degrees F to 250 degrees F.
      - 2) Ambient: 32 degrees F to 125 degrees F.
    - c. Maximum Operating Pressure: As noted.
  - 3. Performance:
    - a. Flowrate Range: As noted.
    - b. Accuracy: Plus or minus 2 percent of maximum flow, uncalibrated, over 12.5:1 turndown.
    - c. Repeatability: 0.5 percent of full scale.
  - 4. Features:
    - a. Nominal Length: 10 inches.
    - b. Float Material: Type 316 stainless steel.
    - c. Tube: Borosilicate glass.
    - d. Seal:
      - 1) Type: O-ring, unless otherwise noted.
      - 2) Material: Buna-N, unless otherwise noted.
    - e. Polycarbonate operator protection shield.
    - f. Mounting: In line, unless otherwise noted.
    - g. Scales: Direct-reading external metal scale, unless otherwise noted.
    - h. Pressure Drop Design: Standard, unless otherwise noted.

- 5. Size and Process Connections:
  - a. Connection Size: As noted.
  - b. Tube Size: As noted.
  - c. Connection Material: Type 316 stainless steel, unless otherwise noted.
  - d. Connection Type: Threaded NPT, unless otherwise noted.
  - e. Connection Orientation: Vertical, unless otherwise noted.
- 6. Signal Interface: None, unless otherwise noted.
- 7. Manufacturers and Products:
  - a. Emerson Process Management Brooks; Series 1100.
  - b. Endress & Hauser; Proline Promass.
  - c. McCrometer; Water Specialties.
- F. P3 Pressure Differential Transmitter:
  - 1. General:
    - a. Function:
      - 1) Measure differential pressure.
      - 2) Transmit signal proportional to either differential pressure or square root of differential pressure, as applicable.
    - b. Type:
      - 1) Electronic variable capacitance or silicon strain gauge.
      - 2) Two-wire transmitter; "smart electronics."
      - Parts: Transmitter and accessories.
  - 2. Performance:

c.

- a. Range: 0-30 PSID.
  - 1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
- b. Accuracy: Plus or minus 0.10 percent of span, unless otherwise noted.
- c. Ambient Operating Temperature: Minus 40 to 175 degrees F, with integral meter.
- d. Process Operating Temperature: Minus 40 to 250 degrees F.
- e. Humidity: 0 to 100 percent relative humidity.
- f. Hazardous Location Certifications: If and as noted.
- 3. Features:
  - a. Linear or square-root output, user-configurable.
  - b. Factory preconfigure for square-root output if transmitter tagged as "FT" or "FIT."
  - c. Adjustable damping.
  - d. LCD indicator, unless otherwise noted.
    - 1) Display in either percent or engineering units, field-configurable.

- e. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
  - 1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
- f. Wetted O-rings: Glass-filled TFE, graphite-filled PTFE, or Viton, unless otherwise noted.
- g. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
- h. Fill Fluid: Silicone, unless otherwise noted.
- 4. Process Connections:
  - a. Line Size: 1/2 inch.
  - b. Connection Type: FNPT.
  - c. Direct/remote Diaphragm Seal: If and as noted.
- 5. Signal Interface:
  - a. 4 to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
    - 1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
  - b. FOUNDATION Fieldbus Protocol: If noted.
  - c. Profibus: If noted.
- 6. Enclosure:
  - a. Type: NEMA 4X.
  - b. Materials: Coated aluminum, unless otherwise noted.
  - c. Mounting bracket, unless otherwise noted.
    - 1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
- 7. Accessories:
  - a. Three-valve manifold, unless otherwise noted.
    - 1) Includes one equalization and two isolation valves.
    - 2) Type 316 stainless steel.
- 8. Manufacturers and Products: Rosemount; Model 3051 CD.
- G. P4 Pressure Gauge:
  - 1. General:
    - a. Function: Local pressure indication.
    - b. Type: Bourdon tube element.
  - 2. Performance:
    - a. Scale Range: 0-30 psi.
    - b. Accuracy: Plus or minus 0.50 percent of full scale.
  - 3. Features:
    - a. Dial: 4-1/2-inch diameter.
    - b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
      - 1) Liquid filled gauge front, unless otherwise noted.
        - a) Glycerine fill, unless otherwise noted.

- c. Case Material: Black thermoplastic, unless otherwise noted.
- d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
  - 1) Stainless steel, unless otherwise noted.
- e. Pointer: Adjustable by removing ring and window.
- f. Window: Glass or acrylic, unless otherwise noted.
- g. Threaded reinforced polypropylene front ring.
- h. Case Type: Solid front with blow-out back.
- 4. Process Connection:
  - a. Mounting: Lower stem, unless otherwise noted.
  - b. Size: 1/2-inch MNPT, unless otherwise noted.
- 5. Accessories:
  - a. Throttling Device: Required, unless otherwise noted.
    - 1) Type suitable for the intended service.
    - 2) Install in gauge socket bore.
- 6. Manufacturers and Products: Rosemount; Model 3051 series.
- H. P8 Pressure Switch, Fixed Deadband:
  - 1. General:
    - a. Function: Monitor pressure.
    - b. Type: Diaphragm-actuated switch.
  - 2. Performance:
    - a. Setpoint:
      - 1) 28 PSI.
      - 2) Repeatability: Plus or minus 1 percent.
      - b. Range: Noted setpoint shall fall between 20 and 80 percent of range.
      - c. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
      - d. Operating Temperature Range:
        - 1) Dependent on actuator seal materials.
        - 2) For Buna-N seal, 0 to 150 degrees F.
  - 3. Features:
    - a. Actuator Seal: Buna-N, unless otherwise noted.
    - b. Differential (deadband): Fixed.
    - c. Reset: Automatic, unless otherwise noted.
    - d. Mounting: Surface, unless otherwise noted.
  - 4. Process Connection:
    - a. 1/4-inch NPT female connections, unless otherwise noted.
    - b. Materials: Nickel-plated brass, unless otherwise noted.
  - 5. Enclosure: NEMA 4X.

- 6. Signal Interface:
  - a. Contact Type:
    - 1) SPDT, unless otherwise noted.
    - 2) Rated for 10 amps minimum at 120V ac.
  - b. Hermetically Sealed Switch: If noted.
- 7. Manufacturers and Products: Rosemount; Model 3051 series.
- I. P9 Pressure Transmitter:
  - 1. General:
    - a. Function: Measure pressure and transmit signal proportional to pressure.
    - b. Type:
      - 1) Electronic variable capacitance or silicon strain gauge.
      - 2) Two-wire transmitter; "smart electronics".
    - c. Parts: Transmitter and accessories.
  - 2. Performance:
    - a. Range: 0-15 PSI.
      - 1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
    - b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
    - c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
    - d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
    - e. Humidity: 0 to 100 percent relative humidity.
    - f. Hazardous Location Certifications: If and as noted.
  - 3. Features:
    - a. Type: Gauge pressure, unless otherwise noted.
    - b. Adjustable damping.
    - c. LCD indicator, unless otherwise noted.
      - 1) Display in either percent or engineering units, field configurable.
    - d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
      - 1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
    - e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
    - f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
    - g. Fill Fluid: Silicone, unless otherwise noted.

- 4. Process Connections:
  - a. Line Size: 1/2 inch.
  - b. Connection Type: FNPT.
  - c. Direct/remote Diaphragm Seal: If and as noted.
- 5. Signal Interface:
  - a. 4mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
    - Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
  - b. FOUNDATION fieldbus protocol: If noted.
  - c. Profibus: If noted.
- 6. Enclosure:
  - a. Type: NEMA 4X.
  - b. Materials: Coated aluminum, unless otherwise noted.
  - c. Mounting bracket, unless otherwise noted.
    - 1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
- 7. Accessories:
  - a. Two-valve (isolate and vent) Stainless Steel Manifold: If noted.
- 8. Manufacturers and Products:
  - a. Gauge Pressure Units: Rosemount; Model 3051 TG.
  - b. Absolute Pressure Units: Rosemount; Model 3051 TA.
- J. Programmable Logic Controllers:
  - 1. Single, local chassis, self-contained CPU, memory, and I/O (expandable to 8 modules). DIN-rail or panel-mounted.
  - 2. Electrical requirements of 85 to 265V ac (120 to 220V ac nominal).
  - 3. CPU capabilities:
    - a. 16 built-in PIDs.
    - b. 100 instructions.
    - c. 30K memory.
  - 4. Controller connections: 16K I/O.
  - 5. Network and Communication connections:
    - a. Modbus TCP.
    - b. RS232 Serial.
  - 6. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, tags, and other necessary functions.
  - 7. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.
  - 8. Programming Environment: Direct Soft 6.
  - 9. Manufacturers and Products: Automation Direct; Direct Logic 454.

- K. Operator Interface Terminal:
  - 1. Display: 10-inch minimum color TFT-LCD active Touchscreen with 18-bit color graphics, Panel-mounted. Provide environmental cover to protect screen for outdoor use.
  - 2. Project Memory: 26 MB.
  - Communication ports/hardware necessary for network communication.
    a. 10/100 BASE TX Ethernet.
  - 4. Power Supply:
    - a. 24V dc input.
    - b. Maximum Power Consumption: 35 W.
  - 5. Environmental:
    - a. Operating Temperature: 0 to 55 degrees C.
    - b. Storage Temperature: Minus 20 to 60 degrees C.
    - c. Permissible Humidity: 10 to 95 percent, noncondensing.
  - 6. Programming Environment: C-more.
  - 7. Manufacturers and Products: Automation Direct; C-more EA9.
- L. Human Machine Interface Client:
  - 1. Panel PC, Industrial-grade, Full HD Touchscreen, minimum19 inch screen.
  - 2. Windows 10, 256 SSD drive (minimum), 16 GB RAM (minimum): Supply with Keyboard and Mice.
  - 3. Ports:
    - a. Minimum 1 USB, backwards compatibility 3.0/2.0.
    - b. Local Area Network, minimum 1 Ethernet: 10/100/1000 Mbps compatibility.
  - 4. Environment:
    - a. Operating Temperature: -40 degrees to 140 degrees F.
    - b. Ingress Protection: IP65, IP66.
    - c. Provide environmental cover to protect screen for outdoor use.
  - 5. Power: 24V dc input.
  - 6. Manufacturers and Products: Advantech PPC series.
- M. Ethernet Switch:
  - 1. Full compliance with IEEE 802.3. Layer two software.
  - 2. Provide network switching for up to eight Ethernet ports within a single chassis. Provide preinstalled pluggable small form factor connectors for LC fiber connections.
  - 3. Ports:
    - a. 10/100BASE-TX: Up to eight ports.
    - b. 100BASE-FX: Minimum two ports.
  - 4. Network Topology: Ring or star.

- 5. Management: Web interface, SNMP v1, v2, with SNMPv3 for security.
- 6. Diagnostics:
  - a. LEDs (power, link status, data, fault, redundancy manager, ringport, LED test).
  - b. Log file.
  - c. RMON (statistics, history alarms, events).
  - d. Port mirroring.
- 7. DIN-rail mountable.
- 8. Operating Temperature: Minus 10 to 60 degrees C.
- 9. Input Power: 24V dc, 3-15 W.
- 10. Protection Class: IP20.
- 11. Approvals: UL 508.
- 12. Manufacturers and Products: Phoenix Contact, FL Switch.
- N. Uninterruptible Power Supply (UPS):
  - 1. Power: 120V ac.
  - 2. Battery: Maintenance-free sealed lead-acid battery with suspended electrolyte; leakproof.
  - 3. Size for 30-minute runtime.
  - 4. Efficiency: Minimum 85 percent at 100 percent load.
  - 5. Operating Temperature: 32 to 104 degrees F.
  - 6. Operating Humidity: 0 to 90 percent.
  - 7. Features:
    - a. Internal, automatic or manual, bypass.
    - b. LED control panel; audible alarms.
    - c. Dry contacts for external outputs:
      - 1) UPS Battery OK.
      - 2) UPS on Utility.
      - 3) UPS Fail Status.
  - 8. Manufacturers and Products: APC Smart-UPS.

## PART 3 EXECUTION (NOT USED)

# **END OF SECTION**

## SECTION 40 99 90 PACKAGE CONTROL SYSTEMS

## PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
  - 2. International Society of Automation (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
  - 3. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
    - c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
  - 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
  - 5. UL: 508A, Standards for Safety, Industrial Control Panels.
- B. As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

## 1.02 DEFINITIONS

A. As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

## 1.03 SYSTEM DESCRIPTION

- A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer's factories.
- B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer's factory.

## 1.04 SUBMITTALS

- A. Action Submittals:
  - 1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
  - 2. Catalog information on electrical devices furnished with system.

- 3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
- 4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
- 5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
- 6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces. Use wire numbers to identify terminals.
- 7. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize the following.
  - a. Required voltages, currents, and phases(s).
  - b. Maximum heat dissipations Btu per hour.
  - c. Calculations.
  - d. Steady-state Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 100 degrees F. Calculation shall account for solar radiation.
- B. Informational Submittals:
  - 1. Control Hardware Submittals:
    - a. Control Hardware: PLC, operator interface terminal, Ethernet switch.
    - b. Complete set of user manuals.
    - c. Fully documented ladder logic listings.
    - d. Function listing for function blocks not fully documented by ladder logic listings.
    - e. Cross-reference listing.
    - f. Data exchange tables for supervisory control and data acquisition (SCADA) integration:
      - 1) List status and commands tags.
      - 2) List alarm tags.
      - 3) List process data tags.
      - 4) List historian data tags.
      - 5) List IP addresses.
  - 2. Manufacturer's list of proposed spares, expendables, and test equipment.
  - 3. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
  - 4. As defined in Section 40 90 00, Instrumentation and Control for Process Systems. Coordinate final list of required submittals during coordination meeting.

# 1.05 ENVIRONMENTAL REQUIREMENTS

- A. Standard Environmental Requirements: Unless otherwise noted, design equipment for continuous operation in the following environments.
  - 1. Freestanding Panel and Consoles, and Smaller Panels and Assemblies (that are not Freestanding):
    - a. Inside, Air Conditioned: NEMA 12.
    - b. Outside, Corrosive: NEMA 4X.
  - 2. Field Elements: Outside.
- B. Environmental Design Requirements: Following defines the types of environments referred to in the above.
  - 1. Inside, Air Conditioned:
    - a. Temperature:
      - 1) Normal: 60 to 80 degrees F.
      - 2) With Up to 4-Hour HVAC System Interruptions: 40 to 105 degrees F.
    - b. Relative Humidity:
      - 1) Normal: 10 percent (winter) to 70 percent (summer).
      - 2) With Up to 4-Hour HVAC System Interruption: 10 to 100 percent.
    - c. NEC Classification: Nonhazardous.
  - 2. Outside, Corrosive:
    - a. Temperature: Minus 20 to 104 degrees F.
    - b. Relative Humidity: 0 to 100 percent, rain.
    - c. Corrosive Environment: Sea air.
    - d. NEC Classification: Nonhazardous.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

## 1.07 EXTRA MATERIALS

- A. Spares, Expendables, and Test Equipment:
  - 1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
  - 2. Light Bulb: 100 percent, 2 minimum, of each type used.
  - 3. Fuse: 100 percent, 5 minimum, of each type used.
  - 4. Surge Suppressors: 20 percent, one minimum, of each type used.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. Section 40 90 00, Instrumentation and Control for Process Systems.
- B. As shown on the Drawings, furnish all equipment and materials as required.

### 2.02 SIGNAL CHARACTERISTICS

- A. Analog Signals:
  - 1. 4 to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
  - 2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
  - 3. Transmitters: Load resistance capability conforming to Class L.
  - 4. Fully isolate input and output signals of transmitters and receivers.
- B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.
  - 1. Power source: Less than 30V dc.
- C. Discrete Signals:
  - 1. Two-state logic signals.
  - 2. Utilize 120V ac sources for control and alarm signals.
  - 3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.
- D. As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

#### 2.03 CORROSION PROTECTION

- A. Corrosion-Inhibiting Vapor Capsule Manufacturers:
  - 1. Northern Instruments; Model Zerust VC.
  - 2. Hoffmann Engineering; Model A-HCI.

### 2.04 CONTROL PANEL FABRICATION

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA. Conform to NEMA ratings as specified in individual equipment sections.

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- B. Minimum 60 inches by 24 inches; Freestanding with Floor Mounts or Pedestals, capable of being attached to rack for additional stability.
- C. Minimum Metal Thickness: 14 gauge.
- D. NEMA 4X; Environment: Outside, Corrosive.
- E. Finish:
  - 1. Environment: Outside, Corrosive; Painted white Type 316 stainless steel.
  - 2. Internal Surfaces: White enamel.
- F. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.
- G. Doors:
  - 1. Hinged dead-front outer door. OIT, control switches and lights mounted on inner door. All other control hardware (e.g., PLC, power supplies, relays) mounted on back panel of control panel.
  - 2. Three-point latching mechanisms in accordance with NEMA 4X panels with doors higher than 18 inches.
  - 3. For other doors, stainless steel quick-release clamps.
  - 4. Door contacts for intrusion detection monitoring into SCADA.
- H. Minimum of one laptop shelf, door-mounted and hinged to fold, for panels 12 cubic feet and larger.
- I. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.
- J. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
- K. Lighting: Minimum of one hand switch controlled internal 100-watt incandescent light for panels 12 cubic feet and larger.
- L. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.
- M. Temperature Control:
  - 1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.

- 2. Furnish refrigerated system where heat dissipation cannot be adequately accomplished with natural convection. Oversize panels to accommodate refrigerated system
- 3. Furnish cooling fans with air filters if required to dissipate heat.
- 4. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.
- N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.
  - 1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.
- O. Panel Manufacturers:
  - 1. Hoffman.
  - 2. H.F. Cox.
- P. Solar shield/Rain hood: Provide for outside environment.

#### 2.05 CONTROL PANEL ELECTRICAL

- A. In accordance with Division 26, Electrical.
- B. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" in accordance with UL 508A.
- C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL-listed.
- D. Control Panel:
  - 1. Do not furnish with motor starters.
  - 2. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
  - 3. Furnish with an uninterruptible power supply (UPS) sized and rated to supply full load for a minimum of 30 minutes.
  - 4. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
  - 5. Circuit Breakers:
    - a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
    - b. Branch Circuit Breakers: 15 amps at 250V ac.
    - c. Breaker Manufacturers and Products:
      - 1) Heineman Electric Co.; Series AM.
      - 2) Airpax/North American Philips Controls Corp.; Series 205.

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- E. Terminal Blocks:
  - 1. Quantity:
    - a. For external connections.
    - b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
    - c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
  - 2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
    - a. Connection Type: Screw connection clamp.
      - b. Compression Clamp:
        - 1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
        - 2) Guides strands of wire into terminal.
      - c. Screws: Hardened steel, captive, and self-locking.
    - d. Current Bar: Copper or treated brass.
    - e. Insulation:
      - 1) Thermoplastic rated for minus 55 to 110 degrees C.
      - 2) Two funnel shaped inputs to facilitate wire entry.
    - f. Mounting:
      - 1) Rail.
      - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      - 3) End Stops: One at each end of rail, minimum.
    - g. Wire Preparation: Stripping only.
    - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
    - i. Marking System:
      - 1) Use wire numbers to identify terminals.
        - a) Terminal number shown on both sides of terminal block.
        - b) Terminal strip numbers shown on end stops.
      - 2) Allow use of preprinted and field marked tags.
  - 3. Terminal Block, 120-Volt Power:
    - a. Rated Voltage: 600V ac.
    - b. Rated Current: 30 amp.
    - c. Wire Size: 22 through 10 AWG.
    - d. Rated Wire Size: 10 AWG.
    - e. Color: Gray body.
    - f. Spacing: 0.25 inch, maximum.
    - g. Manufacturer and Product: Entrelec; Type M4/6.
  - 4. Terminal Block, Ground:
    - a. Wire Size: 22 through 12 AWG.
    - b. Rated Wire Size: 12 AWG.
    - c. Color: Green and yellow body.

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- d. Spacing: 0.25 inch, maximum.
- e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
- f. Manufacturer and Product: Entrelec; Type M4/6.P.
- 5. Terminal Block, Blade Disconnect Switch:
  - a. Use: Provide one for each discrete input and output field interface wire.
  - b. Rated Voltage: 600V ac.
  - c. Rated Current: 10 amp.
  - d. Wire Size: 22 through 12 AWG.
  - e. Rated Wire Size: 12 AWG.
  - f. Color: Gray body, orange switch.
  - g. Spacing: 0.25 inch, maximum.
  - h. Manufacturer and Product: Entrelec; Type M4/6.SN.
- 6. Terminal Block, Fused, 24V dc:
  - a. Rated Voltage: 600V dc.
  - b. Rated Current: 6.3 amp.
  - c. Wire Size: 22 through 12 AWG.
  - d. Rated Wire Size: 12 AWG.
  - e. Color: Gray body.
  - f. Fuse: 5 by 20 GMA fuses.
  - g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
  - h. Indication: LED diode 24V dc.
  - i. Leakage Current: 5.2 mA, maximum.
  - j. Spacing: 0.32 inch, maximum.
  - k. Manufacturer and Product: Entrelec; Type M4/6.SFD.
- 7. Terminal Block, Fused, 120V ac:
  - a. Rated Voltage: 600V ac.
  - b. Rated Current: 6.3 amp.
  - c. Wire Size: 22 through 12 AWG
  - d. Rated Wire Size: 12 AWG.
  - e. Color: Gray body.
  - f. Fuse: 5 by 20 GMA fuses.
  - g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
  - h. Indication: Neon lamp 110V ac.
  - i. Leakage Current: 1.8 mA, maximum.
  - j. Spacing: 0.32 inch, maximum
  - k. Manufacturer and Product: Entrelec; Type M4/6.SFL.
- F. Relays:
  - 1. General:
    - a. Relay Mounting: Plug-in type socket.

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- b. Relay Enclosure: Provide dust cover.
- c. Socket Type: Screw terminal interface with wiring.
- d. Socket Mounting: Rail.
- e. Furnish holddown clips.
- 2. Control Circuit Switching Relay, Nonlatching:
  - a. Type: Compact general purpose plug-in.
  - b. Contact Arrangement: 3 Form C contacts.
  - c. Contact Rating: 10A at 28V dc or 240V ac.
  - d. Contact Material: Silver cadmium oxide alloy.
  - e. Coil Voltage: As noted or shown.
  - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
  - g. Expected Mechanical Life: 10,000,000 operations.
  - h. Expected Electrical Life at Rated Load: 100,000 operations.
  - i. Indication Type: Neon or LED indicator lamp.
  - j. Push-to-test button.
  - k. Manufacturer and Product: Potter and Brumfield; Series KUP.
- 3. Control Circuit Switching Relay, Latching:
  - a. Type: Dual coil mechanical latching relay.
  - b. Contact Arrangement: 2 Form C contacts.
  - c. Contact Rating: 10A at 28V dc or 120V ac.
  - d. Contact Material: Silver cadmium oxide alloy.
  - e. Coil Voltage: As noted or shown.
  - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
  - g. Expected Mechanical Life: 500,000 operations.
  - h. Expected Electrical Life at Rated Load: 50,000 operations.
  - i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
- 4. Control Circuit Switching Relay, Time Delay:
  - a. Type: Adjustable time delay relay.
    - b. Contact Arrangement: 2 Form C contacts.
    - c. Contact Rating: 10A at 240V ac.
    - d. Contact Material: Silver cadmium oxide alloy.
    - e. Coil Voltage: As specified or shown.
    - f. Operating Temperature: Minus 10 to 55 degrees C.
    - g. Repeatability: Plus or minus 2 percent.
    - h. Delay Time Range: Select range such that time delay setpoint fall between 20 to 80 percent or range.
    - i. Time Delay Setpoint: As specified or shown.
    - j. Mode of Operation: As specified or shown.
    - k. Adjustment Type: Integral potentiometer with knob external to dust cover.
    - l. Manufacturer and Products:
      - 1) Potter and Brumfield:
        - a) Series CB for 0.1-second to 100-minute delay time ranges.
        - b) Series CK for 0.1- to 120-second delay time ranges.

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- G. Wiring:
  - 1. ac Circuits:
    - a. Type: 600-volt, Type MTW stranded copper.
    - b. Size: For current to be carried, but not less than 14 AWG.
  - 2. Analog Signal Circuits:
    - a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
    - b. Size: 18 AWG, minimum.
  - 3. Other dc Circuits.
    - a. Type: 600-volt, Type MTW stranded copper.
    - b. Size: 18 AWG, minimum.
  - 4. Special Signal Circuits: Use manufacturer's standard cables.
  - 5. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
  - 6. Enclose wiring in sheet metal raceways or plastic wiring ducts.
  - 7. Wire Identification: Numbered and tagged at each termination. Use wire numbers to identify terminals.
    - a. Wire Tags: Machine-printed, heat shrink.
    - b. Manufacturers:
      - 1) Brady PermaSleeve.
      - 2) Tyco Electronics.
- H. Wiring Interface:
  - 1. For analog and discrete signal, terminate at numbered terminal blocks.
  - 2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
  - 3. For panel, terminate at equipment on/with which it is mounted.
  - 4. For wires entering or leaving enclosures, terminate and identify as follows, identify wiring in accordance with Section 26 05 05, Conductors.
    - a. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.
- I. Power Distribution:
  - 1. Within Panels:
    - a. Feeder Circuits:
      - 1) One or more 120V ac, 60-Hz feeder circuits as shown on the Drawings.
      - 2) Make provisions for feeder circuit conduit entry.
      - 3) Furnish terminal board for termination of wires.

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- b. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
  - 1) Locate to provide clear view of and access to breakers when door is open.
  - 2) Breaker sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
    a) Branch Circuit Breaker: 15 amps at 250V ac.
  - 3) Breaker Manufacturers and Products: Refer to Division 26, Electrical.
- c. Circuit Wiring: P&IDs and control diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
  - 1) Devices on Single Circuit: 20, maximum.
  - 2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
  - 3) Branch Circuit Loading: 12 amperes continuous, maximum.
  - 4) Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
  - 5) Provide 120V ac plugmold for panel components with line cords.
- J. Signal Distribution:
  - 1. Within Panels: 4 to 20 mA dc signals may be distributed as 1 to 5V dc.
  - 2. Outside Panels: Isolated 4 to 20 mA dc only.
  - 3. All signal wiring twisted in shielded pairs.
- K. Signal Switching:
  - 1. Use dry circuit type relays or switches.
  - 2. No interruption of 4 to 20 mA loops during switching.
  - 3. Switching Transients in Associated Signal Circuit:
    - a. 4 to 20 mA dc Signals: 0.2 mA, maximum.
      - b. 1 to 5V dc Signals: 0.05V, maximum.
- L. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.
- M. Front-of-panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:
  - 1. Potentiometer Units:
    - a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
    - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
    - c. Include legend plates with service markings.

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- 2. Indicating Lights:
  - a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
  - b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
- 3. Pushbutton, Momentary:
  - a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
  - b. Standard size legend plates with black field and white markings for service legend.
- 4. Selector Switch:
  - a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
  - b. Standard size, black field, legend plates with white markings, for service legend.
  - c. Operators: Black knob type.
  - d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
- 5. Manufacturers and Products:
  - a. Allen-Bradley; Model 800T series.
  - b. Square D; Class 9001, Type K series.
- N. Front-of-panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:
  - 1. Potentiometer, Watertight:
    - a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
    - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
    - c. Include engraved legend plates with service markings.
  - 2. Indicating Lights, Watertight:
    - a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
    - b. Screwed-on prismatic lenses and factory engraved legend plates for service legend.
  - 3. Pushbutton, Momentary, Watertight:
    - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
    - b. Standard size, black field, legend plates with white markings for service legend.

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- 4. Selector Switch, Watertight:
  - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
  - b. Standard size, black field, legend plates with white markings, for service legend.
  - c. Operators: Black knob type.
  - d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
- 5. Manufacturers and Products:
  - a. Allen-Bradley; Type 800H series.
  - b. Square D; Class 9001, Type SK series.
- O. Intrinsic Safety Barriers: Refer to Section 40 91 00, Instrumentation and Control Components, Electrical Requirements.
- P. Electrical Surge and Transient Protection: Refer to Section 40 91 00, Instrumentation and Control Components, Electrical Requirements.
- Q. Power Supplies: Refer to Section 40 91 00, Instrumentation and Control Components, Electrical Requirements.
- R. Network Interface Panel: Refer to Section 40 91 00, Instrumentation and Control Components, Electrical Requirements.
- S. Programmable Logic Controllers: Refer to Section 40 91 00, Instrumentation and Control Components, I&C Components.
- T. Operator Interface Terminal: Refer to Section 40 91 00, Instrumentation and Control Components, I&C Components.
- U. Ethernet Switch: Refer to Section 40 91 00, Instrumentation and Control Components, I&C Components.
- V. Uninterruptible Power Supply: Refer to Section 40 91 00, Instrumentation and Control Components, I&C Components.

### 2.06 I&C COMPONENTS

A. I&C components shall adhere to standards defined in Section 40 91 00, Instrumentation and Control Components.

### 2.07 MECHANICAL SYSTEMS

A. Mechanical systems shall adhere to standards defined in Section 40 91 00, Instrumentation and Control Components.

### SWF BAF IMPROVEMENTS

### 2.08 INSTRUMENT TAG NUMBERS

A. Instrument tag numbers as shown on P&IDs. Where not shown, tag numbers shall adhere to standards defined in Section 40 90 00, Instrumentation and Control for Process Systems supplement Control System Configuration Standards.

### 2.09 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

- A. Panel Nameplates: Enclosure identification located on the enclosure face.
  - 1. Location and Inscription: As shown.
  - 2. Materials: Laminated plastic attached to panel with stainless steel screws.
  - 3. Letters: 1/2-inch black on white background, unless otherwise noted.
  - B. Nametags: Permanently mounted bearing entire ISA tag number.
    - 1. Panel-mounted: Plastic, mounted to instrument behind panel face.
    - 2. Field-mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.
  - C. Service Legends (Integrally Mounted with Instrument) and Nameplates:
    - 1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
    - 2. Color: White with black letters.
    - 3. Letter Height: 3/16 inch.
    - 4. For each panel, face-mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2 inch high.
  - D. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber

Tag	Inscription(s)	Color
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

1. Lettering: Black on white and amber lenses; white on red and green lenses.

E. Standard Pushbutton Colors and Inscriptions:

Tag Function	Inscription(s)	Color
00	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
МА	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

1. Use following unless otherwise noted in individual Loop Specifications.

- 2. Lettering Color:
  - a. Black on white and yellow buttons.
  - b. White on black, red, and green buttons.

### 2.10 PROCESS CONTROL

- A. Control Narratives:
  - 1. As defined in process mechanical sections for horizontal filter package and other packages related to process control.
  - 2. Program PLC to accomplish control narratives set forth in the process mechanical sections of this Project. Additional information can be found in Section 40 90 00 Supplement 4, Loop Descriptions.
  - 3. Package system supplier shall provide data exchange tables to process instrumentation and control supplier (PICS) and/or PICS integrator.
- B. Loop Descriptions:
  - 1. As defined in Section 40 90 00 Supplement 4, Loop Descriptions.
  - 2. PICS and/or PICS integrator is responsible for SCADA integration.
  - 3. Package supplier is responsible for local monitoring and alarming of door intrusion and shall provide this information on operator interface terminal.
  - 4. Package supplier is responsible for local monitoring and alarming of UPS statuses to include, on battery, on utility, battery health, and shall provide this information on operator interface terminal. Upon loss of utility power, package supplier shall program the control system to retain last known state of operation, then safely shutdown, and provide local alarms on operator interface terminal. Upon return of utility power, package supplier shall program the control system to reset to last know state of operation.

### PART 3 EXECUTION

### 3.01 ELECTRICAL POWER AND SIGNAL WIRING

- A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.
- B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

- C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.
- D. Do not splice or tap wiring except at device terminals or terminal blocks.

# 3.02 PROTECTION

- A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.
- B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

# 3.03 SCADA INTEGRATION

- A. SCADA integration shall be done by PICS or PICS integrator.
- B. Coordinate and provide data exchange tables to PICS or PICS integrator to properly control, monitor, alarm, and historize data in accordance with Owner's requirements.
- C. Coordinate IP addresses of control hardware (PLC, operator interface terminal, Ethernet switch) with existing SCADA system. Provide IP addresses to Owner and PICS or PICS integrator.

# **END OF SECTION**

### SECTION 44 42 19.04 ROTARY POSITIVE DISPLACEMENT BLOWER

### PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Gear Manufacturers Association (AGMA).
  - 2. American National Standards Institute (ANSI).
  - 3. ASTM International (ASTM):
    - a. A48/A48M, Standard Specification for Gray Iron Castings.
    - b. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
  - 4. National Electrical Manufacturers Association (NEMA).

#### 1.02 DEFINITIONS

- A. Absolute Discharge Pressure: Pressure in pounds per square inch absolute (psia) at the blower discharge flange in relation to Job Site barometric pressure.
- B. Brake Horsepower (BHP): (Shaft) Standard curve horsepower required, corrected for pressure, temperature, and relative humidity at inlet conditions.
- C. Discharge Pressure: Pressure in pounds per square inch gauge (psig) at blower discharge flange at rated capacity.
- D. Inlet Cubic Feet per Minute (icfm): Volumetric rate of air at the inlet flange of the blower corrected to absolute pressure, temperature, and relative humidity. The pressure takes into account the inlet piping in filter pressure drops.
- E. Pressure Rise: Pressure developed within the blower between the inlet and outlet flanges. It is the discharge pressure less the inlet pressure measured at the discharge and inlet flanges, respectively.
- F. Standard Cubic Feet per Minute (scfm): Volumetric rate of air measured in standard cubic feet per minute at 68 degrees F, pressure of 14.2 psig, and relative humidity of 36 percent.

### 1.03 SYSTEM DESCRIPTION

A. Blower system, featuring rotary positive displacement blower(s) to supply air for the filter backwash process system.

B. Provide blower system, including, but not limited to, blowers, control panel, motors, drives, guards, drive couplings, baseplates, vibration isolators, supports, inlet silencers, discharge silencers, bypass silencers, relief valves, flexible connectors, complete noise enclosures, spare parts, outside air filter, smart motor starter and miscellaneous appurtenances as necessary.

### 1.04 DESIGN REQUIREMENTS

- A. Design equipment with due regard to safety of operation, accessibility, and durability of parts, and complying with applicable OSHA, state, and local safety regulations.
- B. Each blower will receive outside air from a dedicated filter and discharge into a main air discharge header.
- C. Intermittent and continuous operation in an outdoor environment.
- D. Blower(s) shall start no more than four times per hour when operating in intermittent service.
- E. Blowers shall meet rated performance and sound level when operating at a maximum gear tip speed of 3,750 feet per minute. Operating speed shall not exceed 80 percent of rated speed.
- F. Maximum Sound Pressure Level: 93.5 dBA, factory calculated, with inlet and discharge silencers, measured with a sound enclosure.

Design Conditions		
Design Capacity, scfm	1,200	
Design Capacity, icfm	1,339	
Maximum Capacity, icfm	1,376	
Altitude, ft	10.0	
Barometric pressure, psia	14.7	
Inlet pressure at compressor flange, psia	14.7	
Inlet air temperature, degrees F (Guarantee Point)	78	
Inlet air temperature range, degrees F	33 min to 100 max	
Relative humidity, % (Guarantee Point)	93%	
Discharge pressure at compressor discharge flange, psia	24.7	
Blower pressure rise required, psi	10.0	
Pressure relief valve setting, psig	11.0	

G. Performance Requirements:

# 1.05 SUBMITTALS

- A. Action Submittals:
  - 1. Shop Drawings:
    - a. Complete list of system components to be provided.
    - b. Make, model, weight, and horsepower of each equipment assembly.
    - c. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
    - d. Standard and specialized equipment assembly cuts.
    - e. System layout, installation, and placing drawings for equipment, drivers, and bases.
    - f. Performance data for each type of equipment that will show compliance with specification requirements stated herein.
    - g. Horsepower demand over the operating range of the blower.
    - h. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work.
    - i. Motor: See requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
    - j. Monitoring System:
      - 1) Catalog cuts of each blower control system component, including monitoring panel components.
      - 2) Wiring diagrams, including baseplate-mounted terminal junction box and equipment monitoring panel.
      - 3) Panel construction and face layout drawings.
    - k. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
    - 1. Sound Enclosure: Complete description of sound enclosure and accessories.
      - 1) Calculated noise attenuation.
  - 2. Samples: Color samples for finish coating. If paint manufacturer of finish coat differs from manufacturer of prime coat, provide both manufacturers' written confirmation that materials are compatible.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
  - 3. Factory calculated sound levels (dBA) of blower unit with silencers; and sound enclosure.

- 4. Identification of outside utility requirements for each component such as air, water, power, etc. Include operating parameters for required utilities.
- 5. Special shipping, storage and protection, and handling instructions.
- 6. Manufacturer's written installation instructions.
- 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
- 8. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- 9. Routine maintenance requirements prior to plant startup.
- 10. Test Reports:
  - a. Factory test reports for blower and motor.
  - b. Field test procedures.
- 11. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
- 12. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

### 1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Inlet Filters	Enough for 2 complete change per unit
Flexible Coupling	One complete set per unit
Special tools required to maintain or dismantle	One complete set for each unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

### PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. General:
  - 1. Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.
  - 2. Manufacture spare parts to United States standard sizes and gauges.

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- B. Materials, equipment, and accessories specified in this section shall be products of:
  - 1. Atlas Copco; Model ZL.
- C. No "or-equal" or substitute products will be considered.

### 2.02 COMPONENTS

- A. Blower:
  - 1. Rotary positive displacement type, belt driven by horizontal electric motor.
  - 2. Casing: One-piece construction, ASTM A48/A48M, Class 30B close-grain cast iron strongly ribbed to prevent distortion at the specified operating conditions. Separate headplates of cast iron.
  - 3. Bearings:
    - a. Support shaft and impeller assembly by double-row spherical roller bearings sized for a minimum L10 rating of 100,000 hours.
    - b. Drive End Bearings: Fixed to control axial location of impeller assembly.
    - c. Bearings and Gears: Lubricated by a splash type lubrication system on both ends of the rotors.
    - d. Provide bearings with a positive lip type oil seal designed to prevent lubricant from entering airstream and a labyrinth seal on each shaft designed to reduce air leakage at point where shaft extends through headplate of blower casing.
    - e. Make further provision to vent area between the two sealing systems to atmosphere to relieve excessive pressure on seals.
  - 4. Impellers:
    - a. Provide impeller/shaft assemblies integrally cast from highstrength ASTM A395/A395M Type 60-45-15 ductile iron with a minimum tensile strength of 60,000 pounds per square inch.
    - b. Straight, two-lobe involute type, rotating in opposite directions in a common casing without rubbing, liquid seals, or lubrication.
    - c. Positioned by timing gears to maintain proper clearances.
    - d. Mount impellers and timing gears on shafts supported by antifriction bearings, fixed to control the axial location of impeller/shaft in the casing.
    - e. Statically and dynamically balanced by removing metal from impeller body.
    - f. Positively timed by a pair of accurately machined and carburized steel spur gears hardened to 58-62 Rockwell alloy timing gears manufactured to comply with AGMA. Gears mounted on shafts with tapered fit and secured by a locknuts.

- 5. Shafts:
  - a. Cast iron, integral with impellers.
  - b. Machine labyrinth seals into shaft to minimize air leakage.
- 6. Belt Drive:
  - a. V-belt drive with automatic belt tension device.
  - b. Minimum service factor of 1.4.
  - c. Designed not to exceed allowable overhung load limits of blower and motor.
  - d. Provide belt guard with acoustical treatment.
- B. Motor:
  - 1. Squirrel-cage ac induction type, meeting requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
  - 2. Motor Horsepower: 100.
  - 3. Nominal Speed: 3575 rpm, constant.
  - 4. Rated Voltage: 460 volt, three-phase, 60 Hz.
  - 5. Enclosure Type: TEFC as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
  - 6. Drive: V-belt drive.
  - 7. Motor Efficiency: Premium efficiency as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
  - 8. Service Factor: 1.15.
- C. Blower Support:
  - 1. Baseplate: Cast iron or fabricated steel mounted on concrete equipment pad as shown on the Drawings.
  - 2. Support Stand: Designed by manufacturer and reinforced to withstand anticipated loadings of blower, motor, inlet and discharge silencers, and associated piping.
  - 3. Factory mount blower and motor as a package.
  - 4. Provide vibration isolators to limit transmission of vibration to anchor points at floor.

### 2.03 ACCESSORIES

- A. Air Inlet Filter:
  - 1. Provide individual filters for each blower.
  - 2. Provide 98 percent removal efficiency of particles 10 micron and above and 94.2 percent removal of particles greater than 5 microns in size.
  - 3. Provide unit capable of withstanding wind loads to 100 mph if installed outdoors.

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- 4. Centrifugal action followed by polyester cartridge type air intake filer (Filtration class acc. DIN 24185/EN779).
- 5. Per blower supplier recommendations as included in \_\_\_\_\_.
- B. Inlet, Discharge Silencers:
  - 1. Designed to reduce pulsation from rotary lobe blowers at blower operating timing gear speed.
  - 2. Reactive discharge silencer.
  - 3. Inlet/Outlet Air Velocity: 5,500 feet per minute, maximum.
  - 4. Pressure Loss: 6 inches of WC maximum, through silencer at design flow rate.
  - 5. Inlet and outlet flanges shall match the piping size shown on the Drawings and blower flanges.
    - a. Flange Drilling: 125-pound ANSI standard.
  - 6. Provide drain coupling and plug.
- C. Flexible Connectors:
  - 1. Pressure spool, single arch, expansion joint type with 125-pound ANSI flanges, sized to match blower flanges.
  - 2. Operating Temperature Rating: 250 degrees F.
  - 3. Install on each blower at inlet and outlet flange.
  - 4. Thrust restraint rods on discharge if not otherwise restrained.
  - 5. Manufacturers and Products:
    - a. Mercer; Style 500.
    - b. General Rubber; Style 101.
- D. Check Valve:
  - 1. Flap non-return swing type.
  - 2. Seat: Viton or Silicone for high temperature operation.
- E. Safety Relief Valve:
  - 1. Flanged, spring type.
  - 2. Sized to relieve entire discharge flow without overloading blower.
  - 3. Furnish one for each blower.
  - 4. Mount on discharge piping as shown.
- F. Temperature Sensor:
  - 1. Provide HIGH discharge air temperature sensor, rated NEMA 4, for each blower.
  - 2. Locate sensor directly after blower discharge.

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- G. Noise Enclosure:
  - 1. Total Noise Enclosure: 85 dBA average noise level at 1 meter.
- H. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- I. Equipment Identification Plates: Provide 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch-high die-stamped block type black enamel filled equipment identification number and letters indicated in this specification.
- J. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

### 2.04 INSTRUMENTATION AND CONTROLS

- A. Instrumentation and Controls: In accordance with Section 40 99 90, Package Control Systems. External signal interfaces are required to interface with facility's SCADA System. Provide items not specifically called out which are required to implement functions required for proper system operation.
- B. Control Panel:
  - 1. Panel Power Requirements: 120V ac, single-phase, 20 amp.
  - 2. NEMA Rating: 4X.
  - 3. Mounting: Pedestal.
  - 4. Hand Switches:
    - a. As shown on the Drawings.
  - 5. Indicating Lights:
    - a. As shown on the Drawings.
  - 6. Miscellaneous:
    - a. RUN time meter.
    - b. High inlet vacuum shutdown.
    - c. Discharge High Temperature Shutdown: 0-degree to 350-degree range, NEMA 4X mounted, field adjustable, as manufactured by Ashcroft.
    - d. Discharge High Pressure Shutdown: 5 psig to 15 psig range, NEMA 4X mounted, field adjustable, as manufactured by Ashcroft.
    - e. Inlet and Discharge Pressure Gauges: Liquid filled, 4.5-inch face, as manufactured by Ashcroft.

- f. Inlet and Discharge Temperature Gauges: Minus 20 degrees F to 120 degrees F inlet, 50 degrees F to 400 degrees F discharge, 5-inch-diameter dial every angle, as manufactured by Ashcroft.
- C. Control Panel External Interfaces:
  - 1. Discrete Outputs:
    - a. Dry contacts shall be noble metal or hermetically sealed, and suitable for 5 amps at 120V ac.
    - b. REMOTE status.
    - c. Common FAIL alarm contact that closes on the occurrence of any of the following conditions:
      - 1) HIGH differential air pressure.
      - 2) HIGH discharge temperature
      - 3) Motor OVERTEMP.
  - 2. Discrete Inputs:
    - a. START/STOP.
    - b. HIGH differential air pressure from field devices.
  - 3. Contacts:
    - a. Material: Gold or silver.
    - b. Minimum Rating: 5 amps, 28V dc.
    - c. Discrete Outputs:
      - 1) Alarm: Single-pole, double-throw (SPDT) dry type.
      - 2) Other: Single-pole, single-throw (SPST) dry type.
  - 4. Data Exchange with Existing Plant SCADA System:
    - a.
- D. System Operation:
  - 1. Functional Requirements:
    - a. Provide at each panel:
      - 1) RESET pushbutton and associated logic for the common FAIL alarms. When alarm condition occurs, indicate associated condition at panel. Local indication of alarm condition shall remain until condition has been corrected and RESET pushbutton pressed.
      - 2) Control logic to monitor operation of blower and provide a contact closure output to motor control center when prestartup or operating conditions are normal. Open contact if a HIGH differential air pressure between blower inlet and outlet condition or HIGH discharge air temperature is detected.
      - 3) Indicate blower shutdown and problem using latching relays.
- E. Shop/Factory Finishing: Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

#### SWF BAF IMPROVEMENTS

### 2.05 SOURCE QUALITY CONTROL

- A. Blower Performance Test:
  - 1. Notify Engineer at least 7 days prior to performing test.
  - 2. Perform on the blower actually furnished in accordance with manufacturer's established criteria.
  - 3. Test each blower for a minimum of 1 hour after stabilization at conditions near the performance ratings for mechanical integrity and flow performance.
    - a. Perform at or above specified performance pressure rise.
    - b. Tolerance on Flow: Plus or minus 4 percent, after correction to rated conditions.
  - 4. Perform Slip Test in accordance with manufacturer's established criteria.
    - a. Describe the testing configuration.
    - b. Document operating conditions, temperatures, pressures, blower speed, etc.
    - c. Complete slip calculations at test conditions.
  - 5. Measure power consumption using a calibrated wattmeter.
  - 6. Test Report: Confirm capacity and power, complete with data and calculations used in the test.
- B. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. In accordance with manufacturer's written instructions.
- B. Install one check valve in the blower discharge piping, downstream of the silencer and safety relief valve.
- C. Anchor Bolts: Accurately place using templates furnished by manufacturer and as specified in Section 05 50 00, Metal Fabrications.
- D. Install blower package on vibration isolators and anchor bolts in strict accordance with manufacturer's written instructions.

### 3.02 FIELD QUALITY CONTROL

- A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
- B. Functional Test: Prior to facility startup, conduct on each Blower System, assisted by manufacturer's representative, for correct rotation, proper alignment and connection, quiet operation, and satisfactory specified performance.

ROTARY POSITIVE DISPLACEMENT BLOWER 44 42 19.04 - 10

# 3.03 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
  - 1. 1-person-day(s) for installation assistance and inspection.
  - 2. 1-person-day(s) for functional testing and completion of Manufacturer's Certificate of Proper Installation.
  - 3. 1-person-day(s) for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

# **END OF SECTION**

### SECTION 44 42 56.02 HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

## PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Petroleum Institute (API):
    - a. Standard 610, Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries.
    - b. Standard 670, Machinery Protection Systems.
  - 2. Hydraulic Institute (HI) Standards:
    - a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
    - b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
  - 3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
  - 4. NSF International (NSF):
    - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
    - b. NSF/ANSI 372, Drinking Water System Components Lead Content.

### 1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

### 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Make, model, weight, and horsepower of each equipment assembly.
  - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
  - 3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.

- 4. Detailed mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of components. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, and materials of construction lists. Baseplate drawings with leveling jackscrew details, anchor bolt and sleeve details, and minimum foundation installation and leveling requirements.
- 5. Power and control wiring diagrams, including terminals and numbers.
- 6. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
- 7. Factory finish system.
- 8. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to requirements specified herein.
  - 3. Special shipping, storage and protection, and handling instructions.
  - 4. Manufacturer's printed installation instructions.
  - 5. Factory Functional and Performance Test Reports and Log. Factory test data for each pump shall be submitted, reviewed, and approved by Engineer prior to shipment of equipment.
  - 6. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
  - 7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
  - 8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
  - 9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

### 1.04 EXTRA MATERIALS

- A. Furnish for each pump:
  - 1. Complete set bearings.
  - 2. Complete set gaskets and O-ring seals.
  - 3. Complete set keys, dowels, pins, etc.
  - 4. Complete mechanical seal.
  - 5. One complete set of special tools required to dismantle pump.

HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS 44 42 56.02 - 2

# PART 2 PRODUCTS

### 2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
  - 1. Use or reuse of components and materials without a traceable certification is prohibited.

### 2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

### 2.03 SHAFT SEALS

- A. Mechanical Seal Requirements:
  - 1. Nonfretting type requiring no wearing sleeves for the shafts.
  - 2. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area.
  - 3. Split Type:
    - a. Requiring no field assembly other than assembly around shaft and insertion into pump or balanced cartridge design in conjunction with a spool type spacer coupling as specified in pump data sheet.
    - b. Nonshaft O-rings shall be of ball and socket type requiring no gluing.
    - c. Initial seal installation at factory shall be with nonsplit seal faces, with spare seals and spare kits to have split faces.
    - d. Unless otherwise specified, shall be capable of 400 psig service, be self-aligning, self-centering, single.
    - e. Manufacturer and Product: A.W. Chesterton Company; Chesterton 442.
  - 4. Arrangement shall allow removal of seal without disturbing pump or driver.
  - 5. For clear water services and solids up to 5 percent by weight, face combination shall be hard/soft. Otherwise, hard/hard faces shall be used.
  - 6. Designed so dynamic O-ring moves towards a clean surface as face wears and springs are not in pumped fluid.
  - 7. Face shall be spring loaded to provide self-aligning despite stuffing box misalignment.

- 8. Where cartridge type mechanical seals are specified:
  - a. Single, balanced, flexible stator design.
  - b. Capable of 600 psig service.
  - c. O-ring secondary seals and setscrew drive with three-point centering to ensure 0.003 inch of maximum perpendicularity of rotary face to shaft.
  - d. Gland shall have flush port and be affixed to equipment with adjustable tabs to fit irregular bolt patterns.
  - e. Manufacturers and Products:
    - 1) A.W. Chesterton Company; 155.
      - 2) Crane; 1B.
- 9. Seal Materials:
  - a. Metals:
    - Loaded Parts Over 0.060-inch Cross Section: Type 316 stainless steel minimum.
    - 2) Thinner Parts (springs): Hastelloy-C, Alloy 20, AMS5876 Elgiloy, or other alloy that is not vulnerable to chloride stress corrosion.
  - b. Elastomers: Fluorocarbon Viton, preferred unless seal manufacturer recommends ethylene propylene for service conditions.
  - c. Faces: Homogeneous construction. Surface treatments and plated faces are unacceptable.
    - Acceptable hard faces include nickel bound tungsten carbide, self-sintered silicon carbide, reaction bonded silicon carbide, or graphitized silicon carbide. Silicon carbide is preferred because of its higher pressure-velocity capability.
    - 2) Acceptable soft face is carbon-graphite, either Union Carbide 658RC or Purecarbon P8412.
- 10. Seal Environmental Controls:
  - a. Pipe seal flush port to drain to wet well or hub drain as shown on the Drawings with a 1/8-inch orifice plate in the line. Provide venting of seal chamber.
  - b. Mechanical seals for anything other than clear water services shall be fitted with Enviroseal SpiralTrac Version F, N, or D, installation Type I as recommended by A.W. Chesterton Company.
    - 1) Provide fluid circulation in seal chamber that removes frictional heat from mechanical seal.
    - 2) Convey particulate matter and contaminants for removal by conveying them from bore to shaft by means of integral machined spiral.
    - 3) Removes particulate matter from seal chamber, without seal flush water, through integral machined exit groove.

HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS 44 42 56.02 - 4

- c. Material of construction shall be Type 316 stainless steel.
- d. Connect mechanical seal to water purge supply where indicated on the Drawings.

#### 2.04 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

### 2.05 FACTORY FINISHING

A. Prepare and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

### 2.06 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.
- C. Factory Test Report: Include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.
- D. Performance Test:
  - 1. Conduct on each pump.
  - 2. Perform under simulated operating conditions.
  - 3. Test for a continuous 3-hour period without malfunction.
  - 4. Test Log:
    - a. Record the following:
      - 1) Total head.
      - 2) Capacity.
      - 3) Horsepower requirements.
      - 4) Flow measured by factory instrumentation and storage volumes.
      - 5) Average distance from suction well water surface to pump discharge centerline for duration of test.
      - 6) Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

- 7) Calculated velocity head at the discharge flange.
- 8) Field head.
- 9) Driving motor voltage and amperage measured for each phase.
- 5. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.
- E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
- F. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

### PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Level base by means of steel wedges (steelplates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.
- C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 30 10, Structural Concrete. Remove wedges after grout is set and pack void with grout.
- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

### 3.02 FIELD FINISHING

A. As specified in Section 09 90 00, Painting and Coating.

### 3.03 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each pump.
  - 1. Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.

- 2. Vibration Test:
  - a. Test with unit installed and in normal operation, and discharging to connected piping systems at rates between low discharge head and high discharge head conditions specified, shall not develop vibration exceeding 80 percent of limits specified in HIS 9.6.4.
  - b. If unit exhibits vibration in excess of limits specified, adjust or modify as necessary. Unit that cannot be adjusted or modified to conform as specified shall be replaced.
- 3. Test for continuous 3-hour period.
- 4. Test Report Requirements: In accordance with Hydraulic Institute Standards for centrifugal pump tests HIS 14.6.
- B. Performance Test: In accordance with Hydraulic Institute Standards. Performance tests and data reporting for rated conditions shall be conducted at actual speed of pump in the installation.

### 3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative:
  - 1. Present at Site or classroom designated by Owner, for minimum persondays listed below, travel time excluded:
    - a. 1 person-days for installation assistance and inspection.
    - b. 1 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
    - c. 1 person-days for prestartup classroom or Site training.
    - d. 1 person-days for facility startup.
    - e. 1 person-days for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Engineer.
- B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

### 3.05 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification.
  - 1. Horizontal Split-Case Centrifugal Pump Data Sheet.

### **END OF SECTION**

# HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMP DATA SHEET

Tag Numbers: P-40-121			
Pump Name: Backwash Pump			
Manufacturer and Model Number:	(1) Flowserve		
	(2) Peerless Pur	nps	
	(3)		
	(4)		
SERVICE CONDITIONS			
Liquid Pumped (Material and Pe	ercent): <u>Raw wate</u>	er (Backwash Su	ipply)
Pumping Temperature (Fahrenh	eit): Normal: <u>72</u>	Max <u>82</u>	Min <u>64</u>
Specific Gravity at 60 Degrees I	F: <u>1.0</u>	Viscosity Rang	ge: <u>1.0</u>
		рН: <u>5.5 – 9</u>	0.0
Abrasive (Y/N) <u>N</u>	Possible Sc	ale Buildup (Y/	'N): <u>N</u>
Location: Indoor (Y/N): N	Out	door (Y/N): <u>Y</u>	
PERFORMANCE REQUIREMENT	S		
Capacity (US gpm): Rated: 6,00	)0		
Total Dynamic Head (Ft): Rated	1: 62		
Max. Pump Speed at Rated Cap	acity (rpm):		
Constant (Y/N): <u>Y</u>			
Adjustable (Y/N): <u>N</u>			
DESIGN AND MATERIALS			
Pump Type: Horizontal (Y/N)	) <u>Y</u>	Frame-Mou	nted (Y/N) <u>Y</u>
Vertical (Y/N) N	[	Other	
Casing Material: Cast Iron			
PW\JACOBS AMERICAS\D3418006 MARCH 22, 2023 ©COPYRIGHT 2023 JACOBS		HORIZO CEN 44 42 56 0	NTAL SPLIT-CASE TRIFUGAL PUMPS 2 SUPPLEMENT - 1

#### SWF BAF IMPROVEMENTS

Casing Wear Rings (Y/N) Y	Casing Wear Ring Material: Nitronic 60
Impeller: Type: Enclosed	Material: Type 316 SST
Impeller Wear Rings (Y/N) N	_Impeller Wear Ring Material:
Shaft Material: <u>Type 316 SST</u>	Shaft Sleeve Material: Type 316 SST
Shaft Seal: Packing (Y/N) Mechan	ical (Y/N) Type:
Coupling: Falk (Y/N) <u>N</u> Fast: (Y/N)	N Spring-Grid (Y/N) N
Gear Type (Y/N) <u>N</u>	Spacer (Y/N) <u>N</u>
Manufacturer Standard (Y/N) Y	
Baseplate Material: Fabricated Steel	
Drive Type: <u>Direct-Coupled Y</u> Belt N	_ Adjustable Speed Other
<b>DRIVE MOTOR</b> (See Section 26 20 00, Low-Volta	age AC Induction Motors.)
Horsepower: <u>125</u> Voltage: <u>480</u> F	hase: Synchronous Speed (rpm) 3
Service Factor: <u>1.15</u>	
Motor nameplate horsepower shall not be expump curve.	sceeded at any head-capacity point on
Enclosure: DIP <u>N</u> EXP <u>N</u> ODP	<u>N TEFC Y</u>
CISD-TEFC <u>N</u> TENV <u>N</u> WPI <u>N</u>	N WPII <u>N</u> SUBM <u>N</u>
Mounting Type: Horizontal Y	Vertical Solid Shaft
Nonreverse Ratchet (Y/N) <u>N</u>	
<b>REMARKS</b> The thermostats and motor space heate diagram.	r need to be added per the motor control

### SECTION 44 42 56.03 VERTICAL TURBINE PUMPS

### PART 1 GENERAL

### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Bearing Manufacturers Association (ABMA):
    - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
    - b. 11, Load Ratings and Fatigue Life for Roller Bearings.
  - 2. American Petroleum Institute (API):
    - a. 610, Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries.
    - b. 670, Machinery Protection Systems.
  - 3. ASTM International (ASTM):
    - a. A36/A36M, Standard Specification for Carbon Structural Steel.
    - b. A536, Standard Specification for Ductile Iron Castings.
    - c. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
  - 4. Hydraulic Institute Standards (HIS):
    - a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
    - b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
  - 5. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
  - 6. NSF International (NSF):
    - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
    - b. NSF/ANSI 372, Drinking Water System Components Lead Content.

### 1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

### 1.03 SUBMITTALS

- A. Action Submittals:
  - 1. Make, model, weight, and horsepower of each equipment assembly.
  - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

- 3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.
- 4. Pump maximum downthrust or upthrust in pounds.
- 5. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of components.
- 6. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, and materials of construction lists.
- 7. Baseplate drawings with leveling jackscrew details, anchor bolt and sleeve details, and minimum foundation installation and leveling requirements.
- 8. Power and control wiring diagrams, including terminals and numbers.
- 9. Complete motor nameplate data, as defined by NEMA, motor manufacturer, including motor modifications.
- 10. Factory finish system.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required per Section 01 88 15, Anchorage and Bracing.
  - 2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to requirements specified herein.
  - 3. Special shipping, storage and protection, and handling instructions.
  - 4. Manufacturer's printed installation instructions.
  - 5. Factory Functional and Performance Test Reports and Log. Factory test data for each pump shall be submitted, reviewed, and approved by Engineer prior to shipment of equipment.
  - 6. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
  - 7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
  - 8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
  - 9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

# 1.04 EXTRA MATERIALS

- A. Furnish for this pump:
  - 1. Complete set packing.
  - 2. Complete set bearings.
  - 3. Complete set gaskets and O-ring seals.
  - 4. Complete set of shaft sleeves.
  - 5. Complete set keys, dowels, pins, etc.
  - 6. Complete mechanical seal.
  - 7. Bowl wear ring.
  - 8. Head shaft.
  - 9. One complete set of special tools required to dismantle pump.

# PART 2 PRODUCTS

### 2.01 GENERAL

- A. Adjustable Speed Drives:
  - 1. Where required, furnish coordinated operating system complete with pump, driver, and speed controller.
  - 2. Coordinate pump and motor requirements with adjustable speed drive manufacturer and be responsible for the following:
    - a. Torsional vibration of rotating assembly and related stresses.
    - b. Motor thermal rating.
    - c. Structural design of pump and motor assembly.
    - d. Drive capacity for actual motor's nameplate current rating being supplied.
- B. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
  - 1. Use or reuse of components and materials without a traceable certification is prohibited.

### 2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

### 2.03 SHAFT SEALS

A. Sealing system for vertical turbine pump shafts shall be mechanical seal.

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### SWF BAF IMPROVEMENTS

- B. Mechanical Seal Requirements:
  - 1. Nonfretting type requiring no wearing sleeve for shaft.
  - 2. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through seal area.
  - 3. Split Type:
    - a. Requiring no field assembly other than assembly around shaft and insertion into pump or balanced cartridge design in conjunction with a spool type spacer coupling as specified in pump data sheet.
    - b. Nonshaft O-rings: Ball and socket type requiring no gluing.
    - c. Initial seal installation at factory shall be with nonsplit seal faces; spare seals and spare kits to have split faces.
    - d. Unless otherwise specified, capable of 400 psig service, be self-aligning, self-centering, and single.
    - e. Manufacturer and Product: A.W. Chesterton Company; No. 442.
  - 4. Arrangement shall allow removal of seal without disturbing pump or driver.
  - 5. For clear water services and solids up to 5 percent by weight, face combination shall be hard/soft. Otherwise, hard/hard faces shall be used.
  - 6. Design such that dynamic O-ring moves towards a clean surface as face wears and springs are not in pumped fluid.
  - 7. Stationary seal face shall be spring loaded to provide self-aligning despite stuffing box misalignment.
  - 8. Where cartridge type mechanical seals are specified:
    - a. Single, balanced, flexible stator design.
    - b. Capable of 600 psig service.
    - c. O-ring secondary seals and setscrew drive with three-point centering to ensure 0.003-inch maximum perpendicularity of rotary face to shaft.
    - d. Gland shall have flush port and be affixed to equipment with adjustable tabs to fit irregular bolt patterns.
    - e. Manufacturers and Products:
      - 1) A.W. Chesterton Company; 155.
      - 2) Crane; 1B.
  - 9. Seal Materials:
    - a. Metals:
      - 1) Loaded Parts Over 0.060-inch Cross Section: Type 316 stainless steel minimum.
      - 2) Thinner Parts (springs): Hastelloy-C, Alloy 20, AMS5876 Elgiloy, or other alloy that is not vulnerable to chloride stress corrosion.
    - b. Elastomers: Fluorocarbon Viton preferred, unless seal manufacturer recommends ethylene propylene for service conditions.
- c. Faces: Homogeneous construction. Surface treatments and plated faces are unacceptable.
  - 1) Acceptable hard faces include nickel bound tungsten carbide, self-sintered silicon carbide, reaction bonded silicon carbide, or graphitized silicon carbide. Silicon carbide is preferred because of its higher pressure-velocity capability.
  - 2) Acceptable soft face is carbon-graphite, either Union Carbide 658RC or Purecarbon P8412.
- 10. Seal Environmental Controls:
  - a. Pipe seal flush port drain to wetwell or hub drain as shown on the Drawings with 1/8-inch orifice plate in the line. Provide venting of seal chamber.
  - b. Mechanical seals for anything other than clear water services shall be fitted with Enviroseal SpiralTrac Version F, N, or D, installation Type I as recommended by A.W. Chesterton Company.
    - 1) Provide fluid circulation in seal chamber that removes frictional heat from mechanical seal.
    - 2) Convey particulate matter and contaminants for removal by conveying them from bore to shaft by means of integral machined spiral.
    - 3) Remove particulate matter from seal chamber, without seal flush water, through integral machined exit groove.
  - c. Material of Construction: Type 316 stainless steel.
  - d. Connect mechanical seal to water purge supply where indicated on the Drawings.

#### 2.04 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch diestamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. Anchor Bolts: Galvanized, Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

#### 2.05 FACTORY FINISHING

A. Prepare and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

#### SWF BAF IMPROVEMENTS

#### 2.06 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.
- C. Factory Test Report: Include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.
- D. Performance Test:
  - 1. Conduct on each pump at rated speed.
  - 2. Perform under simulated operating conditions.
  - 3. Test for a continuous 3-hour period without malfunction.
  - 4. Test Log: Record the following:
    - a. Total head.
    - b. Capacity.
    - c. Horsepower requirements.
    - d. Flow measured by factory instrumentation and storage volumes.
    - e. Average distance from suction well water surface to pump discharge centerline for duration of test.
    - f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
    - g. Calculated velocity head at the discharge flange.
    - h. Bowl head.
    - i. Driving motor voltage and amperage measured for each phase.
  - 5. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.
- E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
- F. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

#### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.

- C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 30 10, Structural Concrete. Remove wedges after grout is set and pack void with grout.
- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

## 3.02 FIELD FINISHING

A. As specified in Section 09 90 00, Painting and Coating.

## 3.03 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each pump.
  - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
  - 2. Vibration Test:
    - a. Test with unit installed and in normal operation, and discharging to connected piping systems at rates between low discharge head and high discharge head conditions specified, shall not develop vibration exceeding 80 percent of limits specified in HIS 9.6.4.
    - b. If unit exhibits vibration in excess of limits specified, adjust or modify as necessary. Unit that cannot be adjusted or modified to conform as specified shall be replaced.
  - 3. Test for continuous 3-hour period.
  - 4. Test Report Requirements: In accordance with HIS 14.6.
- B. Performance Test: In accordance with Hydraulic Institute Standards.

#### 3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
  - 1. 1 person-days for installation assistance and inspection.

- 2. 1 person-days for functional and performance testing, completion of Manufacturer's Certificate of Proper Installation, and prestartup classroom or Site training.
- 3. 1 person-days for facility startup.
- 4. 1 person-days for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Engineer.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

#### 3.05 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification.
  - 1. Pump Data Sheet.

## **END OF SECTION**

VERTICAL TURBINE PUMP DATA SHEET, 44 42 56.03			
mp No. 1			
(1) Peerless Pumps			
(2)			
(3)			
(4)			
(5)			
al and Percent): <u>Raw Water</u>			
Fahrenheit): Normal <u>72</u> Max <u>82</u> Min <u>64</u>			
Degrees F: <u>1.0</u> Viscosity Range: <u>1.0</u>			
pH: <u>5.5 – 9.0</u>			
_Caused by:			
(Y/N): <u>N</u> Caused by:			
Caused by:			
: <u>Y</u> Outdoor (Y/N): <u>N</u>			
CMENTS			
ed: 6,000 (min. efficiency 81.25%) Secondary: 8,000/ <u>3,000</u>			
): <u>Rated: 77</u> Secondary: <u>68 / 116</u>			
ed Capacity (rpm):			

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## SWF BAF IMPROVEMENTS

# **DESIGN AND MATERIALS**

Pump Type: Open Line Shaft (Y/N) $\underline{Y}$ Enclosed Line Shaft (Y/N) $\underline{N}$
Column: Type 416 SS
Line Shaft Bearings: Fluted synthetic rubber with bronze, ASTM B584 C90500, shells
Discharge Head:
Type:
Material: Fabricated Steel, ASTM A536, Grade 60-40-18
Discharge Nozzle Size (inches): <u>18</u> Flange Standard/Class: <u>150</u>
Suction Can (Y/N): <u>N</u>
Impeller:
Type:
Material: Bronze
Head Shaft Material: <u>Type 416 SS</u> Shaft Sleeve Material:
Shaft Sealing: Packing (Y/N) N Mechanical (Y/N) Y
Type: Cartridge
Seal Lubrication: Pumped Fluid
Coupling: Falk (Y/N) Fast: (Y/N) Spring-Grid (Y/N)
Gear Type (Y/N) Spacer (Y/N)
Manufacturer Standard (Y/N) _Y
Baseplate Material:
Motor Base Material: Carbon Steel ASTM A36/A36M
DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)
Horsepower: <u>150</u> Voltage: <u>480</u> Phase: <u>3</u>
Synchronous Speed (rpm): <u>1770</u>
VERTICAL TURBINE PUMPS 44 42 56.03 SUPPLEMENT - 2 PW\JACOBS AMERICAS\D3418006 MARCH 22, 2023 ©COPYRIGHT 2023 JACOBS

#### SWF BAF IMPROVEMENTS

Service Factor:

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP <u>N</u> EXP <u>N</u> ODP <u>N</u> TEFC <u>Y</u> CISD-TEFC <u>N</u> TEWAC <u>N</u> WPI <u>N</u> WPII <u>N</u>

Mounting Type: Vertical Hollow Shaft <u>N</u> Nonreverse Rathet (Y/N)

Vertical Solid Shaft <u>Y</u>\_\_\_\_

ABMA 9 and ABMA 11, B-10 Motor Bearing Life (hrs):

**REMARKS** <u>Provide Type 316 stainless steel basket strainer suction accessory. Thermostats</u> and motor space heater shall be added per motor control diagram.

## SECTION 44 43 30 FILTER MEDIA

## PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Water Works Association (AWWA):
    - a. B100, Filtering Material.
    - b. B604, Granular Activated Carbon.
    - c. C653, Disinfection of Water Treatment Plants.
  - 2. NSF International (NSF):
    - a. NSF/ANSI 61, Drinking Water System Components Health Effects.
    - b. NSF/ANSI 372, Drinking Water System Components Lead Content.
  - 3. American Society for Testing (ASTM):
    - a. D75, Standard Practice for Sampling Aggregates.
    - b. D2862, Standard Test Method for Particle Size Distribution of Granular Activated Carbon.
    - c. D4607, Standard Test Method for Determination of Iodine Number of Activated Carbon.
    - d. E11, Wirecloth and Sieves for Testing Purposes.
  - 4. Food Chemical Codex: 4th Edition.

#### 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Granular Activated Carbon Submittals:
    - a. Shop Drawings:
      - 1) Name and address of GAC Supplier.
      - 2) Supplier's standard data for proposed silica sand media:
        - a) Sieve analysis (test data and plotted data) of media to be used. Fine media sizes shall be in millimeters.
        - b) Calculated effective size and uniformity coefficient.
        - c) Average apparent specific gravity (wetted), specific, in-place and bulk density of media.
        - d) Total surface area.
        - e) Water Soluble Ash.
        - f) Pore Volume.
        - g) Moisture.
        - h) Abrasion Number.

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- i) Percent Phosphate.
- j) Water Extractables.
- 3) Media compatibility calculations as indicated herein.
- 4) Description of the detailed procedure proposed for placing and removing the media, supplementing as necessary the installation requirements herein.
- 5) List of temporary equipment required for the removal and placement of media.
- 6) Furnish headloss curves for the supplied media during normal filter operation at the required media bed depth (filtration rate ranging from 2 up to 6.5 gpm/ft<sup>2</sup> and water temperature from 68 degrees F to 85 degrees F).
- 7) Furnish filter bed expansion curves for media during backwashing as a percentage of the required bed depth versus backwash water flow rate and water temperature (backwash water flow rate ranging from 15 up to 25 gpm/<sup>ft2</sup> and water temperature from 68 degrees F to 85 degrees F).
- b. Samples: Provide a sample for each lot of granular activated carbon proposed to use. Samples shall be placed in tight jars holding at least 1 quart (1 liter, approximately) and shall be properly labeled to identify the firm and the exact product type and specification sheet. No GAC media shall be shipped prior to sample approval. The granular activated carbon samples shall be tested by an approved third party laboratory to certify compliance with all the requirements. Submit test results for approval.
- c. Test Data: Submit certified test results showing gradation and size for each "lot" or partial "lot" of GAC at the time of shipment to the Site.
- d. Owner's Approval: The Owner's approval of the media samples shall not be construed as signifying that the materials satisfy requirements of these Specifications and shall in no way relieve the Supplier of the obligation to satisfy all requirements herein.
- 2. Detailed filter media handling and installation procedures shall be submitted to the Owner at least 30 days prior to arrival of media to the work Site. Media installation shall not begin until Owner's approval of the procedures.

# PART 2 PRODUCTS

#### 2.01 GENERAL

A. Filter media and filter media testing methods shall conform to the requirements of AWWA B604 Granular Activated Carbon and AWWA B100
 Standard for Filtering Media, except as otherwise indicated.

FILTER MEDIA 44 43 30 - 2 PW\JACOBS AMERICAS\D3418006 MARCH 22, 2023 ©COPYRIGHT 2023 JACOBS

- B. Provide media samples to the Engineer. One sample of each type of media delivered to the Site shall be taken by the Filter Manufacturer and tested in accordance with AWWA B-100 requirements.
- C. The filter media provided in the Work shall be equal to the approved samples. The Engineer may require the media supplier to furnish a sample for test purposes during the preparation and placing of the filter materials.

## 2.02 FILTER MEDIA DEPTHS

A. The depth of each layer of filter media shall be as shown in table below.

Media	Depth (in.)
Granular activated carbon	51

## 2.03 GRANULAR ACTIVATED CARBON MEDIA

- A. General:
  - 1. The GAC is to Be used as a biologically active filter to minimize the fouling potential of the filtered water on downstream membrane processes.
  - 2. Granular activated carbon media shall consist of a 51-inch deep layer of material.
- B. The GAC shall be manufactured by a producer certified for ISO 9001:2001 quality standards, with the specific manufacturing plant holding that specification. Copy of a valid certificate to be submitted with the bid.
- C. Uniformity: The media shall be equal in all respects to the approved samples, and similar samples for test purposes shall be furnished as required by the Owner during the preparation and placing of the filter materials.
- D. Material Quality: The granular activated carbon shall be virgin and composed of hard durable grains. Average apparent specific gravity shall be determined by the procedure set forth in AWWA B604. The granular activated carbon shall meet the physical properties listed below and be manufactured from only selected grades of bituminous coal combined with suitable binders as required to produce a highly active, durable granular material capable of withstanding the abrasion and dynamics associated with repeated backwashing, surface washing, and hydraulic transport. Activation shall be carefully controlled to produce a material having a high internal surface area with optimum pore size for effective adsorption of a broad range of high and low molecular weight organic contaminants. The density and particle size shall be designed for packed bed type of adsorption. The material shall have sufficient density to

PW\JACOBS AMERICAS\D3418006 MARCH 22, 2023 ©COPYRIGHT 2023 JACOBS FILTER MEDIA 44 43 30 - 3 allow backwash agitation and bed expansion yet settle rapidly for immediate resumption of service. The material shall be visually free of foreign materials such as clay, dirt, etc. Lignite, peat, wood, coconut, sub-bituminous and reactivated carbons will not be accepted

- 1. The GAC shall conform to Food Chemical Codex when tested under the conditions of the test outlined in the Food Chemical Codex, 4th edition. The GAC supplied shall have and meet NSF/ANSI 61 approval.
- 2. The material shall have the following physical properties or equivalency (as approved by the Owner) to the following table. Any deviations from specifications must be explained with the corresponding submittal.

Iodine number, (minimum), mg/g	900
Carbon base material	Bituminous coal
Effective Size, mm	1.0 - 1.2
Uniformity Coefficient (maximum)	1.5
Apparent density (backwashed and drained), (g/cc)	0.56
Particle Size (U.S. Sieve Series)	
Larger than No. 8 (maximum %)	5.0
Smaller than No. 20 (maximum %)	4.0
Moisture (maximum as packaged), %	2.0
Abrasion number (minimum, Ro-tap Method)	75
Water soluble ash (typ), %	< 1.0
Total Ash (typ), %	8.0

- E. The granular activated carbon shall be free from any significant amounts of iron sulfides, clay, shale, dust, or other foreign matter.
- F. Particle Size and Gradation: Granular activated carbon to be placed in each filter shall have a uniformity coefficient and size as required below. The particle size shall be determined by screening through standard sieves calibrated in accordance with ASTM E11. Effective size is defined as the theoretical size of the sieve (in millimeters) that will pass 10 percent of the sample by weight. The uniformity coefficient is defined as the theoretical size of the sieve (in millimeters) that will pass 60 percent of the sample by weigh divided by the effective size. No more than 4 percent by weight shall be finer than the lower designated size limit, and not more than 5 percent by weight shall be coarser than the upper designated size limit.

FILTER MEDIA 44 43 30 - 4

- G. Granular Activated Carbon Suppliers:
  - 1. Calgon Corporation, Filtrasorb F820.
  - 2. Norit Americas, GAC 820.
  - 3. Siemens (Westates Carbon), AquaCarb 820.

# PART 3 EXECUTION

## 3.01 GENERAL

- A. All filtration media shall be shipped in bundles of 1/2 or 1 cubic foot volume bags on pallets.
- B. Contractor is responsible for supplying sufficient media to achieve finished bed depths after media skimming.
- C. All filter media is to be field installed by the Contractor with oversite from the media supplier and pressure filter system supplier.
- D. Prior to placing any filter material, the Contractor shall mark the top surface of each layer with a level line on the inside of the filter cell wall.

## 3.02 FILTER MEDIA INSTALLATION

- A. Prior to any media installation the filters shall be cleaned in accordance with ANSI/AWWA B100 Section 4.4. and as described herein. All foreign media will be removed from the filter vessels. The interior shall be cleaned using potable water and tools suitable for adequate scrubbing and cleaning of the interior surfaces. Pump or drain scrub water from the structures after completing the cleaning and rinse all surfaces with potable water.
- B. The placement of filter media will not begin until operational testing of the filter feed pumps, air scour system, and backwash system has been completed.
- C. Installation of GAC:
  - 1. The filters shall be successfully disinfected and tested to meet the requirements per Section 33 13 00, Disinfection of Water Distribution Facilities before the installation of GAC can commence. After disinfection, the filter shall be flushed with potable water prior to placing the GAC.
  - 2. The GAC shall be installed in accordance with Appendix C, Filter Material Placing and Preparation of ANSI/AWWA B604, Granular Activated Carbon.

- 3. The GAC will not be disinfected with free chlorine however the installation procedures shall be done in accordance with ANSI/AWWA C653 Section 4.4.3.5 GAC filters and as described herein. The Contractor shall clean all equipment used in placing GAC with a solution of 200 mg/L free residual chlorine immediately before use. This includes shovels, spreading devices, tools, etc. Workers shall wear rubber boots and gloves that have been disinfected with 200 mg/L of free residual chorine if coming in contact with the GAC entering the filter.
- 4. Special care shall be taken in transporting and placing the granular activated carbon to avoid the possibility of contamination with dirt or organic matter. Any granular activated carbon which may have become dirty, either before or after it has been placed in the filters, shall be either washed or removed and replaced by clean granular activated carbon. Granular activated carbon which has been contaminated by organic matter will be rejected. In placing the granular activated carbon in the filters, extreme care shall be taken to avoid disturbing the layer of filter silica sand.

## 3.03 FILTER WASHING, SCRAPING AND TESTING

- A. Filter washing, scraping, and testing shall be done in accordance with AWWA B100 and B604.
- B. Scraping:
  - 1. Scraping shall be performed after placement of each lift of fluidizable filter media and prior to placing another media above. Per AWWA B604 the GAC shall not be scrapped after installation unless undue head loss develops due to fines.
  - 2. After the initial wash of each layer, the filter shall be partially drained and approximately a 3/16-inch layer of the top material shall be removed from each filter by scraping. The Contractor shall repeat the scraping as many times as necessary to remove the fine material.
  - 3. Washing: the filter bed shall be washed a minimum of 3 times between scrapings. Each wash shall be a minimum of 5 minutes at a rate recommended in AWWA B100 Table 2 and as modified by the media manufacturer.
- C. After the GAC has been placed in accordance with AWWA B604 and herein the filter media shall be leveled and backwashed in accordance with AWWA B604. This shall be done with the Owner or their designated representative present.

- D. The filters shall be washed and tested for media depth one at a time. Water for the initial backwash and testing shall be filtered first.
- E. The media supplier shall provide supervision and equipment to place, remove, and test the GAC.
- F. Affidavit of Compliance: The Contractor shall provide an affidavit of compliance stating that the filter material provided complies with the applicable standards in AWWA B100 and B604, has been successfully disinfected and is ready for service.

# **END OF SECTION**

## SECTION 46 61 01 HORIZONTAL PRESSURE FILTER

## PART 1 GENERAL

#### 1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. NSF International (NSF):
    - a. 61, Drinking Water System Components Health Effects.
    - b. 372, Drinking Water System Components Lead Content.
  - 2. American Welding Society (AWS): D1.1/D1/1M, Structural Welding Code Steel.
  - 3. American Society of Mechanical Engineers (ASME):
    - a. B16.5 Pipe Flanges and Flanged Fittings.
    - b. SEC VIII-1, Section VIII Division 1 Rules for Construction of Pressure Vessels.
  - 4. American Society for Testing and Materials (ASTM): A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
  - 5. American Water Works Association (AWWA): C110/A212.10 Ductile-Iron and Gray-Iron Fittings.

## 1.02 SUBMITTALS

- A. Action Submittals:
  - 1. Drawings showing dimensions, weights, and details of components, piping connections, and wiring for installation and operation.
  - 2. Double line piping drawings (piping schematics will not be acceptable) showing all piping, valves, and accessories furnished with the filters and interconnections with piping and services provided by others.
  - 3. Furnish standard operating procedures.
  - 4. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature, which shall include make, model, dimensions, weights of equipment, and listing of component metallurgy, materials and coatings.
  - 5. Instrumentation and Control (I&C) System Submittals:
    - a. P&ID: Filter System Process and Instrumentation Diagram.
    - b. Block Diagram: A diagram showing all major Programmable Logic Controller (PLC) system components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically. Show wiring terminations to all interfacing elements and subsystems.

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- c. Software Design: Detailed application software documentation. All application software shall be reviewed by the Engineer. Provide preliminary documentation for review at least 4 weeks prior to Performance Testing. Final, as installed, software documentation shall be submitted at the end of the Contract. Include one copy of all application software on disk.
  - 1) Operator Interface Terminal (OIT) Graphic Displays: Full set of machine generated color copies of the displays.
  - 2) PLC Control Strategy: This submittal shall include a written overview description of the ladder logic program to lead the user through the programmed functions for the filter system equipment. The submittal shall also include a fully documented ladder logic listing. Ladder rungs shall have comments that describe the function of the rungs. Provide a comment line per ladder rung. Function block or flow chart programming are also acceptable but must be fully documented and submitted for review and approval. Filter vendor shall advise for approval software programming package and language type prior to beginning system development.
- d. Programming Software: Provide development software licenses for the PLC and OIT programming software (one each). Provide detailed technical reference manuals and user level manuals for system setup, troubleshooting and configuring application software.
- 6. Filter hydraulic calculations, including headlosses for individual filter components, valves, and piping supplied by the filter manufacturer. Calculations and design values should be provided for the range of filter production flowrates and for the range of backwash rates.
- B. Informational Submittals:
  - 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
  - 2. Factory and Field Performance Test Reports and Log.
  - 3. Special shipping, storage and protection, and handling instructions.
  - 4. Manufacturer's printed installation instructions.
  - 5. Manufacturer's Certificate of Compliance, in accordance with the General Requirements Section.
  - 6. Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
  - 7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

HORIZONTAL PRESSURE FILTER 46 61 01 - 2 8. Operation and Maintenance Data as specified in the General Requirements section.

# PART 2 PRODUCTS

- 2.01 GENERAL
  - A. All items of equipment specified herein shall be furnished by one supplier. This Supplier shall have the responsibility of providing the equipment, accessories, and installation supervision required to provide a fully functional filtration system.
  - B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and Supplier's service.
  - C. Note that where specific dimensions, mechanical or structural features, descriptions of mounting requirements, or basic equipment layout and configuration are listed in these Specifications, it shall be understood that this is for purposes of describing the base system only. It is not intended that all manufacturers of competing equipment be required to match the dimensions, geometry, or construction details precisely. Rather, features described will be used as a basis for determining equivalency of competing systems to the base system. Due to space limitations, the Seller shall closely coordinate the design of the equipment with the Facility Layout Drawings included in the Contract Documents.
  - D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
    - 1. Use or reuse of components and materials without a traceable certification is prohibited.

## 2.02 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of the filter system supplier and supplied by one of the following:
  - 1. Hungerford and Terry, Inc., Clayton, NJ.
  - 2. Tonka Equipment Company, Plymouth, MN. (763) 559-2837.
  - 3. The Robert's Filter Group, Darby, PA. (610) 583-3131.

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#### 2.03 SERVICE CONDITIONS

A. Exposure: Filters will be installed outside with temperatures varying between 30 to 105 degrees F. Associated control panels will be outside with temperatures varying between 30 to 105 degrees F.

## 2.04 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Design requirements are as follows:
  - 1. The pressure filter backwash water source is to be water from the ground water storage tank on site.
    - Table 1<br/>Design RequirementsFlow Rate (per Filter)4.32 MGDMaximum Filtration Rate6.4 gpm/ft²Minimum Combined EBCT4.7 minsMaximum Backwash Rate25 gpm/ft²Maximum Backwash Flow<br/>(per Cell)6,000 gpmAir Scour Rate5.0 SCFM/ft²
  - 2. The filter system design requirements are listed in Table 1.

## 2.05 EQUIPMENT DESCRIPTION

- A. All equipment and accessories shall be provided as required for proper functioning systems including, but not limited to, the following:
  - 1. Filter Vessels: System will consist of horizontal pressure filters with the following design parameters:

Number of Filters	2
Filter Diameter	12 ft
Filter Overall Length	40 ft
Number of Cells (per Filter)	2

2. The filter tanks shall be of welded steel construction using SA-516 Grade 70 steel and shall be tested to a hydrostatic pressure 30 percent in excess of the designed working pressure of 100 psi. The tanks shall be constructed in accordance with ASME code Section VIII-1 and provided with ASME stamp.

- 3. Tanks shall include the following features:
  - a. Minimum of one 30-inch circular manway per cell, with spare gaskets for installation in the tank shell.
  - b. Flange pad or nozzle type connections to interface external piping.
  - c. Four lifting lugs minimum.
  - d. Minimum of three structural steel saddle type supports.
- 4. Filter Inlet Distributors:
  - a. Each filter cell shall be equipped with an inlet distributor/backwash collector system. Each header is to extend in from one tank head and serve the length of the respective cell. The distributor is to provide uniform distribution of inlet water over the entire filter bed, and uniform collection of backwash wastewater during the backwash operation.
  - b. The inlet distributors shall be installed by the filter manufacturer prior to shipment.
- 5. Underdrain System:
  - a. Each filter cell shall be equipped with an underdrain system designed to provide uniform collection of filtered water and uniform distribution of backwash water at high and low backwash flow rates.
  - b. The filter underdrains shall be wedge wire wrapped Type 304 stainless steel laterals designed for the full range of filtrate and backwash flows and for the filter media specified in Section 44 43 30, Filter Media. The header laterals will be encased in concrete.
  - c. The underdrain systems shall be installed by the Contractor with oversight of the filter manufacturer.
  - d. Concrete fill for the filters, to support the underdrains, shall be furnished and installed by the Contractor.
- 6. Filtration Media: Filter media shall be supplied and installed in accordance with Section 44 43 30, Filter Media.
- 7. Filter Exterior Valving: Each filter shall be furnished with an exterior valve nest comprised of automatic and manual valves as shown on the P&ID, drawings and in accordance with Section 40 27 02, Process Valves and Operators.
- 8. Filter System Piping:
  - a. Water Piping: All filter face and interconnecting piping and fittings shall be cement lined ductile iron (CLDI) conforming to Section 40 27 01 Process Piping—General and Section 40 27 00.01, Cement-Mortar-Lined Ductile Iron Pipe and Fittings.
  - b. Air Piping: All piping for air scour shall be stainless steel, conforming to Section 40 27 01 Process Piping—General and Section 40 27 00.08, Stainless Steel Pipe and Fittings—General Service.

PW\JACOBS AMERICAS\D3418006 MARCH 22, 2023 ©COPYRIGHT 2023 JACOBS c. The filter system supplier shall indicate on the Drawings the location and type of any pipe supports required. Pipe supports shall be furnished by the Contractor.

#### 2.06 CONTROL SYSTEM

- A. Filter system supplier shall provide all instrumentation and controls in accordance with Section 40 99 90 Package Control Systems, Section 40 91 00, Instrumentation and Control Components, and P&ID Drawings.
- B. Control Panels:
  - 1. Provide the following control panels:

Tag Number	Name
LCP-30-101	Horizontal Pressure Filter Control Panel 1

2. Control panel LCP-30-101 shall be manufactured and constructed in accordance with P&ID drawings and Section 40 99 90, Package Control Systems.

## 2.07 ACCESSORIES

- A. Equipment Identification Plates: An engraved Gravoply laminated identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4-inch minimum identification number indicated in this Specification and/or as shown on the Drawings.
- B. Lifting Lugs:
  - 1. Individual equipment and/or each field disassemble part over 100 pounds in weight shall be provided with lifting lugs for easy handling.
  - 2. Pipe, fittings, valves, and valve operators shall not require lifting lugs.
- C. Anchor Bolts: Submit size, material, and design, Contractor shall supply anchor bolts meeting these requirements.
- D. Labeling and Valve Tags:
  - 1. Pipe Labeling: Brady "Sign More" self-adhesive line designation markers with directional arrows, Type B-946 for exterior service.
  - 2. Valve Tags: Corresponding to valve numbers in O&M manual and on P&ID, 1/16-inch laminate, 1 1/4-inch by 2 1/2-inch, with 1/8 inch drilled hole for mounting to valve with plastic ties.

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- 3. Warning label:
  - a. Stenciled on vessel-"Lined vessel, do not shock, weld or burn."
  - Each filter to have 8 1/2 by 11 Mylar over vinyl warning label adjacent to manway "WARNING-CONFINED SPACE. DO NOT ENTER VESSEL WITHOUT AIR SUPPLY OR SELF-CONTAINED BREATHING APPARATUS."

## 2.08 FACTORY FINISHING

A. Prepare, prime and finish coat the exterior of the filter in accordance with Section 09 90 00, Painting and Coating, System No. 4. Prepare, prime and finish coat the interior of the filter in accordance with Section 09 97 13, Steel Tank Coatings, System No. 1A.

## 2.09 SOURCE QUALITY CONTROL

- A. Factory Inspections:
  - 1. Inspect control panel for required construction, electrical connection, and intended function.
  - 2. Inspect welds on vessels to ASME.
- B. Factory Tests and Adjustments:
  - 1. Test the control panel actually furnished.
  - 2. Hydrostatically pressure test filter pressure vessel per ASME Code.

# PART 3 EXECUTION

## 3.01 INSTALLATION

- A. Equipment shall be installed in accordance with Filter system supplier instructions.
- B. Touch up paint damaged finish with coating compatible with factory finish.
- C. Filter media shall be installed in accordance with Section 44 43 30, Filter Media.
- D. The Filter system supplier shall provide detailed written instructions to the Contractor for filter equipment installation and media installation and provide oversight during such activities.

## 3.02 FIELD FINISHING

A. Contractor shall be responsible for touch up paint of damaged finish in field.

- B. Contractor shall be responsible for finish painting of: Filter face and interconnecting piping and filter exterior valving.
- C. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.
- D. As specified in Section 09 90 00, Painting and Coating and Section 09 97 13, Steel Tank Coatings.

## 3.03 FIELD QUALITY CONTROL

- A. Filter system supplier shall lead field testing for the filter system, in cooperation with the Contractor, as follows:
  - 1. Functional Test: Prior to plant startup, all equipment shall be inspected for proper alignment, proper connection, and satisfactory performance.
  - 2. Field Test: Confirm proper performance of controls and automatic valves.
  - 3. Hydrostatically test filter vessels and related piping.
  - 4. Performance Test: Complete testing to demonstrate compliance to performance criteria detailed in Part 2 of this Specification.
    - a. Buyer will furnish water and pretreatment chemicals necessary for performance testing.

#### 3.04 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at job site or classroom, as designated by Owner, for minimum person-days for each job site as listed below, travel time excluded:
  - 1. 4 person-days for installation assistance and inspection.
  - 2. 4 person-days for functional and performance testing and completion of Manufacturer's Certificates of Proper Installation.
  - 3. 2 person-day for pre-startup classroom or site training of Owner's personnel.
  - 4. 4 person-days for PLC programming and troubleshooting assistance as needed. Plan for not less than two trips. Person shall be personnel responsible for systems programming.
  - 5. 3 person-days for facility startup.
  - 6. 2 person-day for post startup training of Owner's personnel training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Engineer.
- B. See the General Requirements section.

## **END OF SECTION**

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# DRAWINGS (BOUND SEPARATELY)