



North Jersey District Water Supply Commission

TECHNICAL SPECIFICATIONS FOR

NORTH JERSEY DISTRICT WATER SUPPLY COMMISSION CLARIFIER REHABILITATION, BASINS 1-4

November 2021

ISSUED FOR BID

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END OF SECTION

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 upgrades to their existing mixing and sedimentation basins (1 through 4) and includes:
1. Mixing Basins (1 through 4): In summary, the scope of work for the mixing basins is as follows.
 - a. Replace existing baffle walls with new FRP baffle walls.
 - b. Replace existing paddle flocculators with new paddle flocculators.
 - c. Modify flow pattern, which includes serpentine baffling with dedicated paddle flocculators for each pass.
 - d. Replace existing miscellaneous metals and piping.
 - e. Repair existing concrete as needed.
 - f. Install new panels and variable frequency drives (VFDs); connect to supervisory control and data acquisition (SCADA).
 - g. Install lighting.
 - h. Clean and remove existing sludge.
 - i. New electrical, instrumentation and panels.
 2. Upper and Lower Settling Basins (1 through 4): In summary the scope of work for the sedimentation basins is as follows.
 - a. Replace existing cable trac system with new hoseless system.
 - b. Replace existing baffle walls with new fiberglass-reinforced plastic (FRP) baffle walls.
 - c. Replace existing miscellaneous metals and piping.
 - d. Repair existing concrete as needed.
 - e. Replace sludge piping and valves.
 - f. Replace washwater system and associated valves.
 - g. Replace existing control panels with new; connect to SCADA.
 - h. Install lighting.
 3. Influent/Effluent Channels (1 through 4): In summary the scope of work for the influent and effluent channels is as follows.
 - a. Replace existing influent and effluent channel isolation valves.
 - b. Modify channel as necessary.
 - c. Install new turbidimeters and make provisions for future flow meters.
 - d. Replace existing control panels with new; connect to SCADA.
 - e. Install new stop logs.

4. Miscellaneous:
 - a. Provide portable ventilation system for venting basins.
 - b. Install equipment pads for fans.
 - c. Install 480V Receptacles for portable fans.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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.
- D. 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.
 - 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.
3. 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:

1. 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 under the Contract Documents, and (v) extended overheads.

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. Financial arrangements associated with rental and lease transactions that provide Contractor remuneration or discounts not visible to the Owner must be disclosed and integrated with charged rates.
 6. Leased Equipment in Use: Actual equipment use time documented by Engineer shall be the basis that equipment was on and used 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.
7. 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.
 8. 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.
 9. Owned and Other Equipment, When Idle (Standby): Equipment necessary to be onsite to perform the Work on single shift operations, but not used, 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.
 10. 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.
 11. 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.
 12. If the move-out destination is not to the original location, payment for move-out will not exceed payment for move-in.
 13. 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.

14. Charges for time used in servicing equipment to ready it for use prior to moving and similar charges will not be allowed.
15. 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.
16. 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.
17. 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. Application for Payment.
 - 3. Final Application for Payment.

1.02 CASH ALLOWANCES

- A. Consult with Engineer in selection of products or services. Obtain proposals from suppliers and installers, and offer recommendations.
- B. Cash allowances will be administered in accordance with General Conditions.
- C. Submit, with application for payment, invoice showing date of purchase, from whom the purchase was made, the date of delivery of the product or service, and the price, including delivery to the Site and applicable taxes.

1.03 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.
 - a. Mobilization includes, at minimum, items identified in Section 01 50 00, Temporary Facilities and Controls.
 - b. Include item(s) for monthly progress schedule update.
 - 3. Break down by Division 02 through 49.

- 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.

1.04 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.

1.05 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 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.

1.06 MEASUREMENT—GENERAL

- A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

- B. Whenever pay quantities of material are determined by weight, weigh material on scales furnished by Contractor and certified accurate by state agency responsible. Obtain weight or load slip from weigher and deliver to Owner's representative at point of delivery of material.
- C. If material is shipped by rail, car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.
- D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by Engineer. Each vehicle shall bear a plainly legible identification mark.
- E. Haul materials that are specified for measurement by the cubic yard measured in the vehicle in transport vehicles of such type and size that actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. Load vehicles to at least their water level capacity. Loads hauled in vehicles not meeting above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.
- F. Quantities Based on Profile Elevations: Existing ground profiles shown on Drawings were taken from a topographic map drawn with contour intervals of 2 feet with supplementary spot elevations to nearest half-foot.
- G. Quantities will be based on ground profiles shown. Field surveys will not be made to confirm accuracy of elevations shown.
- H. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.
- I. Units of measure shown on Bid Form shall be as follows, unless specified otherwise.

Item	Method of Measurement
AC	Acre—Field measure by Engineer
CY	Cubic yard—Field measure by Engineer within limits specified or shown
CY-VM	Cubic yard—Measured in vehicle by volume
EA	Each—Field count by Engineer

Item	Method of Measurement
GAL	Gallon—Field measure by Engineer
HR	Hour
LB	Pound(s)—Weight measure by scale
LF	Linear foot—Field measure by Engineer
MFBM	Thousand-foot board measure—field measure by Engineer
SF	Square foot
SY	Square yard
TON	Ton—Weight measure by scale (2,000 pounds)

1.07 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 shown on the Drawings and defined in Section 01 11 00, Summary of Work.
- C. Payment for unit price items covers all the labor, materials, and services necessary to furnish and install the following items.
 - 1. Concrete pressure injection repair.
 - 2. Concrete spalling repair.
 - 3. Removal of sludge and anthracite from mixing basins.

1.08 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

- A. Payment will not be made for following:
 - 1. Loading, hauling, and disposing of rejected material.
 - 2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
 - 3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
 - 4. Material not unloaded from transporting vehicle.
 - 5. Defective Work not accepted by Owner.
 - 6. Material remaining on hand after completion of Work.

1.09 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

- A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and preliminary operation and maintenance data is acceptable to Engineer.
- B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

1.10 PARTIAL PAYMENT FOR UNDELIVERED, PROJECT-SPECIFIC MANUFACTURED OR FABRICATED EQUIPMENT

- A. Notwithstanding above provisions, partial payments for undelivered (not yet delivered to Site or not stored in the vicinity of Site) products specifically manufactured for this Project, excluding off the shelf or catalog items, will be made for products listed below when all following conditions exist:
 - 1. Partial payment request is supported by written acknowledgment from Suppliers that invoice requirements have been met.
 - 2. Equipment is adequately insured, maintained, stored, and protected by appropriate security measures.
 - 3. Each equipment item is clearly marked and segregated from other items to permit inventory and accountability.
 - 4. Authorization has been provided for access to storage Site for Engineer and Owner.
 - 5. Equipment meets applicable Specifications of these Contract Documents.
- B. 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.
- C. 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 images within 5 days of being taken. Each image is to have a minimum file size of 1.4 Mb (1,400 Kb) so viewed resolution is high quality. The production of larger file sizes with higher resolution is encouraged.
3. Video Recordings: Submit one copy within 5 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 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. Completion and commissioning of each individual basin system: Each basin is back online and functioning as intended.
 2. Substantial Completion: All systems are able to be used and operated by the Owner.

1.04 WORK SEQUENCING/CONSTRAINTS

- A. Include the following work sequences in the progress schedule:
 - 1. Install new effluent valves; coordinate necessary isolation with Owner. Two basins may be taken out of service for this Work.
 - 2. Complete all Work items associated with one basin, including startup and full return to service, prior to starting next basin. Coordinate isolation with Owner.

1.05 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. Install and maintain bypass facilities and temporary connections required to keep Owner's operations online. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.
- 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.

1.06 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.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs and Article Audio-Video Recordings.
2. 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.

1.07 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 weather and inclement weather.
3. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.
4. Digital Images: No post-session electronic editing of images is allowed. Stored image shall be actual image as captured without cropping or other edits.

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 48 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 1832 by 3264 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. Monthly: Take 30 photographs.
- D. Documentation:
 - 1. Digital Images:
 - a. Electronic image shall have date taken embedded into image.
 - b. Archive using a commercially available photo management system that provides listing of photographs including date, keyword description, and direction of photograph.

1.08 AUDIO-VIDEO RECORDINGS

- A. Prior to beginning the Work on Site or of a particular area of the Work, videograph Site and property adjacent to Site.
- B. In the case of preconstruction recording, no Work shall begin in the area prior to Engineer's review and approval of content and quality of video for that area.
- C. Particular emphasis shall be directed to physical condition of existing vegetation, structures, and pavements within work area and on Contractor storage and staging areas.
- D. Engineer shall have right to select subject matter and vantage point from which videos are to be taken.
- E. Video Format and Quality:
 - 1. DVD quality, with sound.
 - 2. Video:
 - a. Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections.
 - b. Electronically, and accurately display the month, day, year, and time of day of the recording.

3. Audio:
 - a. Audio documentation shall be done clearly, precisely, and at a moderate pace.
 - b. Indicate date, project name, and a brief description of the location of recording, including:
 - 1) Facility name.
 - 2) Street names or easements.
 - 3) Addresses of private property.
 - 4) Direction of coverage, including engineering stationing, if applicable.

F. Documentation: Provide electronic copies only.

1.09 REFERENCE POINTS AND SURVEYS

A. Owner's Responsibilities:

1. Establish benchmarks convenient to Work and at least every 500 feet on pipelines and roads.
2. Establish horizontal reference points or coordinate system with benchmarks and reference points for Contractor's use as necessary to lay out Work.

B. Location and elevation of benchmarks are as follows:

1. The PAC system foundation (not shown on Drawings) has a permanent benchmark. It is 306.00 NAVD 88.

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. Retain professional land surveyor or civil engineer registered in state of Project who shall perform or supervise engineering surveying necessary for additional construction staking and layout.
6. Maintain complete accurate log of survey work as it progresses as a Record Document.
7. On request of Engineer, submit documentation.

8. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
 - a. Check layout, survey, and measurement work performed by others.
 - b. 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 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 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.

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

- A. Owner 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.

1.04 PROGRESS MEETINGS

- A. Owner will schedule regular progress meetings at Site, conducted as necessary 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 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.

1.06 FACILITY STARTUP MEETINGS

- A. Schedule and attend a minimum of two facility startup meetings per basin. 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.

1.07 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 at least 7 days prior to preconstruction conference.
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. Electronic file compatible with latest version of Microsoft Project.
 - c. Progress Schedule: One legible copy.
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 of 120 days, 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.
 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 as needed or requested by Owner to reflect actual progress and occurrences to date, including weather-related 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.
 - 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. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, Summary of Work.
 - g. Sitework.
 - h. Concrete Work.
 - i. Structural steel Work.
 - j. Architectural features Work.
 - k. Conveying systems Work.
 - l. Equipment Work.
 - m. Mechanical Work.
 - n. Electrical Work.
 - o. Instrumentation and control Work.
 - p. Interfaces with Owner-furnished equipment.
 - q. Other important Work for each major facility.
 - r. Equipment and system startup and test activities.
 - s. Project closeout and cleanup.
 - t. 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.

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 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.

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.

1.07 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. Schedule Contingency: Contingency included in progress schedule is a Project resource available to both Contractor and Owner to meet Contract Milestones and Contract Times. Use of schedule contingency shall be shared to the proportionate benefit of both parties.
- D. Float: Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.

E. 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.
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. Deferred Submittal: Information submitted by Contractor for portions of design that are to be submitted to permitting agency for approval prior to installation of that portion of the Work, along with Engineer's review documentation that submittal has been found to be in general conformance with Project's design.
- C. 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 Engineer and Owner via email or Project website.
- B. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format.
 - 1. Each submittal shall be an electronic file in Adobe Acrobat portable document format (PDF). Use the latest version available at time of execution of the Agreement.
 - 2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
 - 3. PDF files shall be set to open "Bookmarks and Page" view.
 - 4. Add general information to each PDF file, including title, subject, author, and keywords.
 - 5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
 - 6. Submit new electronic files for each resubmittal.
 - 7. Include a copy of the Transmittal of Contractor's Submittal form, located at end of section, with each electronic file.
 - 8. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
 - 9. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

C. 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.
 - 1) 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 in format approved by Engineer.
3. Identify each submittal with the following:
 - a. 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.
 - e. Names of Contractor, subcontractor or supplier, and manufacturer as appropriate.
4. Identify and describe each deviation or variation from Contract Documents.

D. 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.

E. Timeliness: Schedule and submit in accordance schedule of submittals and requirements of individual specification sections.

F. 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 14 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.

G. Resubmittals: Clearly identify each correction or change made.

H. 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.

I. 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.

1.03 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings:

1. 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.

2. 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.
3. Product Data: Provide as specified in individual specifications.
4. Deferred Submittal:
 - a. Contractor-design drawings and product data related to permanent construction.
 - 1) Written and graphic information.
 - 2) Drawings.
 - 3) Cut sheets.
 - 4) Data sheets.
 - 5) Action item submittals requested in individual specification section.
 - b. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit required supporting data and drawings for review and acceptance by Engineer. Documentation of review and approval provided on Engineer's comment form, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.
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.

- 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: Electronic.
 2. Approved as Noted:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
 - b. Distribution: Electronic.
 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: Electronic.
 4. Revise and Resubmit:
 - a. Contractor may not incorporate product(s) or implement Work covered by submittal.
 - b. Distribution: Electronic.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Refer to individual specification sections for specific submittal requirements.
2. 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 and Video: 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.
 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. Deferred Submittals:
1. Contractor-design data related to permanent construction:
 - a. List of assumptions.
 - b. List of performance and design criteria.
 - c. Summary of loads or load diagram, if applicable.
 - d. Calculations.
 - e. List of applicable codes and regulations.
 - f. Name and version of design software.
 - g. Factory test results.
 - h. Informational submittals requested in individual specification section.
 2. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit calculations and test results of Contractor-designed components for review by Engineer. Documentation of review and indication of compliance with general design intent and project criteria provided on

Engineer's comment form as meets conditions of the Contract, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.

- G. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual specification section.
- H. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.
- I. 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.
- J. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.
- K. 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.
- L. Special Guarantee: Supplier's written guarantee as required in individual specification sections.
- M. 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.

- N. 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.
- O. 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.
- P. Testing and Startup Data: In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

- Q. Training Data: In accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
11.	AI	Asphalt Institute
12.	AISC	American Institute of Steel Construction
13.	AISI	American Iron and Steel Institute
14.	AITC	American Institute of Timber Construction
15.	ALS	American Lumber Standards
16.	AMCA	Air Movement and Control Association
17.	ANSI	American National Standards Institute
18.	APA	APA – The Engineered Wood Association
19.	API	American Petroleum Institute
20.	APWA	American Public Works Association
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

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

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
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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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 14 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 14 days prior to scheduled training and revise as necessary for acceptance.

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 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.

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 equipment/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 Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

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.

- 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.

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.

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.

- 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.
 - 3) 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.

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 Quality Control 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.
 - 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.
 - 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 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.
 - 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 that 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 Protection 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: Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.

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 sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
 5. Arranging for and erection of Contractor's work and storage yard.
 6. Posting OSHA-required notices and establishing safety programs and procedures.
 7. Having Contractor's superintendent at Site full time.
- B. Location of staging area will be determined during preconstruction meeting.

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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

- A. Power: Electric power will be available at or near Site.
- 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.
 - 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:
 - 1. Hydrant Water: Is available from nearby hydrants.
 - 2. Provide means to prevent water used for testing from flowing back into source pipeline.
- 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. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

3.02 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.
2. 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.
3. 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.
4. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
5. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
6. 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.
7. Maintain original Site drainage wherever possible.

B. Barricades and Lights:

1. Provide as required 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.

C. 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 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 Drawings to be removed, shall be removed without written approval of Engineer.
 - h. Dispose of removed trees in a legal manner off the Site.
2. 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.

D. 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.

E. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

F. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

- G. 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.

3.03 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: Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.

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. 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.

3.04 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.

3.05 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.

3.06 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. Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property for periods greater than 2 hours, provide written notice to each owner so affected 3 days prior to such closure. In such cases, closings of up to 4 hours may be

allowed. Closures of up to 10 hours may be allowed if a week's written notice is given and undue hardship does not result.

- E. Maintenance of traffic is not required if Contractor obtains written permission from Owner and tenant of private property, or from authority having jurisdiction over public property involved, to obstruct traffic at designated point.
- F. Coordinate traffic routing with that of others working in same or adjacent areas.

3.07 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 28
TEMPORARY FLOW CONTROL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. Institute of Inspection, Cleaning, and Restoration Certification (IICRC): S500, Standard and Reference Guide for Professional Water Damage Restoration.

1.02 DEFINITIONS

- A. Bypass Pumping: Temporary flow control accomplished by diverting flow away from the Work area using one or more pumps.
- B. Temporary Flow Control: Reducing, limiting, or excluding flow in or to a sanitary sewer, storm sewer, pump station, force main, or other facility as required for performing the Work under the Contract. Draining, handling, and disposal of sanitary sewage and stormwater from pipelines and other facilities as required for performing the Work under the Contract is also part of temporary flow control.
- C. Temporary Flow Control Plan: Plan prepared by Contractor containing complete information on how Contractor proposes to perform temporary flow control in accordance with specified requirements.

1.03 SYSTEM DESCRIPTION

- A. Provide facilities and controls required to intercept, convey, and discharge flow to be controlled; include standby and emergency equipment.
- B. Conform to regulatory requirements.
- C. Protect water resources, wetlands, and other natural resources.
- D. Temporary flow control shall be done in a manner that will not damage private or public property, or create a nuisance or public menace. Flow shall be conveyed in enclosed pipes that are adequately protected from traffic or other hazards.

E. Discharge:

1. Around bypassed channels and basins.
2. Dumping or free flow on private or public property, gutters, streets, or sidewalks is prohibited.
3. Discharge of sanitary sewage to storm sewers, to surface waters or wetlands, or into the ground, is prohibited.

1.04 SITE CONDITIONS

- A. Existing facilities are shown on Drawings.

1.05 SUBMITTALS

A. Informational Submittals:

1. Temporary flow control plan.
2. Emergency cleanup plan.
3. Special permits required for temporary flow control.
4. Names and qualifications of industrial hygienist and standby cleanup Subcontractor, including but not limited to, certification by IICRC.
5. Information describing equipment and materials to be used and showing conformance with specified requirements.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Industrial Hygienist and Cleanup Subcontractor: Certified by IICRC.
2. Temporary Flow Control System Designer: Professional engineer who has at least 5 years' experience in design of such systems and who is registered in the State of New Jersey.

1.07 SEQUENCING AND SCHEDULING

- A. See Design Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Install temporary flow control facilities only within public right-of-way, Owner's property, temporary construction easement, permanent easement, or easement obtained by Contractor.

- B. Operate and maintain temporary flow control 24 hours per day, 7 days per week, including without limitation, holidays, as required to control flows.
- C. Promptly remove temporary flow control facilities as soon as they are no longer needed.

3.02 EQUIPMENT AND MATERIALS

A. General:

- 1. Provide materials and equipment that will ensure continuous and successful operation of temporary flow control systems.
- 2. Repair or modify systems as necessary.
- 3. Unless otherwise shown or specified, materials and equipment may be new or used at Contractor's option.

B. Plugs:

- 1. Provide with taps for connection of pressure gauges and air hoses, and flow-through capability.
- 2. Pipe Diameters 24 Inches and Smaller: Use mechanical plugs with rubber gaskets or pneumatic plugs with rubber boots.
- 3. Pipe Diameters Larger than 24 Inches:
 - a. Use inflatable bag stoppers made in two or more pieces.
 - b. Manufacturers:
 - 1) Lansas.
 - 2) Cherne Industries.

C. Pumps:

- 1. Fully automatic, self-priming units that do not require use of foot valves or vacuum pumps in priming system.
- 2. Solids handling design with ability to pump minimum 3-inch diameter sphere.
- 3. Able to run dry for long periods of time to accommodate cyclical nature of flows.
- 4. Engine: Equipped to minimize noise. Noise levels shall not exceed 86 dBA at a distance of 50 feet from source.

D. Electric Power Generators:

- 1. Be able to simultaneously start and run electric powered pumps required for flow to be controlled.
- 2. Equipped to minimize noise. Noise levels shall not exceed 86 dBA at a distance of 50 feet from source.
- 3. Include automatic transfer switch if flow control system is to operate unattended.

E. Standby Equipment:

1. Standby Pump: One of each size to be available onsite.
2. Electric Power Generators: Minimum of one if temporary flow control system contains electric powered pump. Able to simultaneously start and run electric powered pumps required for flow to be controlled.

3.03 TEMPORARY FLOW CONTROL PLAN

A. Prepare and submit temporary flow control plan at least 14 days before starting the Work requiring temporary flow control; include following information:

1. Drawings indicating location of temporary sewer plugs and bypass discharge lines.
2. Traffic control plan specifically applicable to temporary flow control adhering to requirements of applicable agencies and as may be specified in Contract Documents.
3. Locations where flow will be intercepted and discharged.
4. If trucks are to be employed include the following:
 - a. Numbers and sizes of trucks.
 - b. Configuration of facilities to be used to load trucks at each interception location.
 - c. Locations where trucks will unload.
 - d. Time for loading, unloading, and travel.
5. Complete descriptions and performance characteristics of pumps, electric power generators, and standby equipment.
6. Acoustical information for equipment to be used showing compliance with noise control requirements of Section 01 50 00, Temporary Facilities and Controls.
7. Details of temporary force mains, including horizontal and vertical alignments, pipe materials, protection of existing buried and aboveground facilities and improvements, maintenance of traffic and access to properties.
8. Design calculations proving adequacy of temporary system and selected equipment to convey all flows.
9. Drawings showing layouts and configurations of temporary flow control facilities and also showing locations relative to right-of-way easement, and property boundaries.
10. Drawings and design calculations of temporary bulkheads and plugs.
11. Drawings and design calculations for thrust restraint of temporary piping.
12. Details of system controls and control logic; include diagrams and narrative.
13. Anticipated schedule for the Work.

14. Other information to completely describe temporary flow control facilities and conformance to specified requirements.

3.04 EMERGENCY CLEANUP PLAN

- A. Prepare and submit not less than 60 days before scheduled date of temporary flow control activities. As a minimum plan shall include the following:
 1. Procedures for removal of water.
 2. Procedures for determining nature and extent of damage and required restoration where restoration is possible.
 3. Provide for industrial hygienist and standby subcontractor for cleanup of exterior and building interior spaces that might be affected by a spill, backup, or overflow. Industrial hygienist and cleanup subcontractor shall be certified by IICRC and follow IICRC S500 for cleanup of Category 3 water.
- B. Implement for full-scale test and during temporary flow control.

3.05 BLOCKING FLOW

- A. Flow control may consist of blocking flow with mechanical or pneumatic plugs if only small amount of flow needs to be controlled and adequate storage is available.
- B. Use primary and secondary plugs for each flow control location.
- C. When blocking flow is no longer needed for performance and acceptance of the Work, remove plugs in a manner that permits sewage flow to slowly return to normal without surcharging or causing other major disturbances downstream.
- D. Remove temporary plugs at end of each working day and restore normal flow. If downstream work is not or cannot be completed during workday provide, operate, and maintain bypass pumping system or other method of flow control to accommodate flows.

3.06 PIPING

- A. Minimize disturbance of existing utilities.
- B. Where temporary flow control pipelines cross streets and private driveways, install pipeline in trench and cover with temporary pavement.
- C. Installation of bypass pipelines is prohibited in salt marsh/wetland areas.

3.07 FIELD QUALITY CONTROL

A. Hydrostatic Pressure Test for Pump Bypass Systems:

1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times maximum operating pressure of system.
2. Notify Engineer and Owner 24 hours prior to testing.

B. Full-scale Test:

1. At least 14 days prior to test, notify Engineer of date and time of test.
2. Do not begin temporary flow control activities until successful test has been completed.
3. Conduct on proposed temporary flow control at least 14 days before scheduled date of actual proposed temporary flow control.
4. Purpose of test is to demonstrate capability, function, and reliability of Contractor's proposed method of temporary flow control.
5. Duration: Minimum of 2 hours.
6. Conduct between 8:00 a.m. and 4:00 p.m. Do not conduct test on Saturday, Sunday, or holiday.
7. If electric pumps are being used, provide standby generators to ensure continuity of pumping operation in event of power failure.
8. Demonstrate system controls and operation, reliability, and transfer to standby equipment during test.
9. Conduct until flow is accommodated for minimum specified test duration.
10. Failure:
 - a. Test shall be deemed to have failed if during test flows are not accommodated for whatever reason and for whatever length of time.
 - b. If test fails, determine and correct deficiencies that caused test to fail and conduct another full-scale test.
11. Determination by Engineer of a successful test, permission by Engineer to proceed with the Work requiring temporary flow control, or anything else shall not relieve Contractor from responsibility to provide temporary flow control.

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 DESIGN REQUIREMENTS

- A.** Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of latest edition of International Building Code (IBC) by International Code Council (ICC).

1.03 ENVIRONMENTAL REQUIREMENTS

- A.** Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 323 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 0 degrees F to 100 degrees F.

1.04 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.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.05 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.
- 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.

1.06 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.
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 gray 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.
- 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. 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 product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

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. Special bonds, special guarantees, and service agreements.
 - c. Consent of Surety to Final Payment: As required in General Conditions.
 - d. Releases or Waivers of Liens and Claims: As required in General Conditions.
 - e. Releases from agreements.
 - f. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
 - g. 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.

1.03 RELEASES FROM AGREEMENTS

- A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.
- B. In the event Contractor is unable to secure written releases:
 - 1. Inform Owner of the reasons.
 - 2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
 - 3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
 - 4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate claims that Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

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 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 Drawings.
 - 2) Red when showing information added to 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.
 - 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 operation 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 compilation formatted and electronic media formatted data prior to Substantial Completion of Project.
- 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 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 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. Electronic Media Format:

1. Portable Document Format (PDF):
 - a. After all preliminary data has been found to be acceptable to Engineer, submit O&M data in PDF format on CD or other approved method.
 - 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 two 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 two copies revised in accordance with Engineer's comments.
3. Final Data: Submit two 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 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 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.
 - 3) Disassembly, removal, repair, reinstallation, and re-assembly.
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:
 - a. Electrical service.
 - b. Control requirements and interfaces.
 - c. Communication requirements and interfaces.
 - d. List of electrical relay settings, and control and alarm contact settings.
3. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
4. As-installed control diagrams by control manufacturer.
5. Operating Procedures:
 - a. Routine and normal operating instructions.
 - b. Startup and shutdown sequences, normal and emergency.
 - c. Safety precautions.
 - d. Special operating instructions.
6. Maintenance Procedures:
 - a. Routine maintenance.
 - b. Guide to troubleshooting.
 - c. Adjustment and checking.
 - d. List of relay settings, control and alarm contact settings.
7. Manufacturer's printed operating and maintenance instructions.
8. 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. Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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 _____

a. Name _____ Telephone No. _____

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 asterisks.				

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 mixing basin flocculators, settling basin sludge collection system, influent and effluent valves, HVAC system, lighting system, etc.
- 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 O&M 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.
- 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 as chosen by Contractor to meet schedule requirements.
- 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 including its computer system, 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 description and equipment number of all equipment and devices):

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, 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 Signature)

SECTION 02 41 00 DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
 - 2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
 - 3. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
 - a. Part 61—National Emission Standards for Hazardous Air Pollutants.
 - b. Part 82—Protection of Stratospheric Ozone.
 - c. Part 273—Standards for Universal Waste Management.
 - 4. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.

1.02 DEFINITIONS

- A. ACM: Asbestos-containing material.
- B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.
- C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.
- D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.
- E. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

- F. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.
- G. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

- 1. Submit proposed demolition plan, in accordance with requirements specified herein, for approval before such Work is started.
- 2. Submit copies of any notifications, authorizations and permits required to perform the Work.
- 3. Submit a shipping receipt or bill of lading for all universal waste shipped.

1.04 REGULATORY AND SAFETY REQUIREMENTS

- A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.
- B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor's safety requirements shall conform to ANSI A10.6.
- C. Furnish timely notification of this demolition project to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.

1.05 DEMOLITION PLAN

A. Demolition plan shall provide for safe conduct of the Work and shall include:

- 1. Detailed description of methods and equipment to be used for each operation.
 - 2. The Contractor's planned sequence of operations, including coordination with other work in progress.
 - 3. Disconnection schedule of utility services.
- B. Include statements affirming Contractor inspection of the existing roof deck, floors, walls, and framing members, and their suitability to perform as a safe working platform or, if inspection reveals a safety hazard to workers, state

provisions for securing the safety of the workers throughout the performance of the Work.

1.06 SEQUENCING AND SCHEDULING

- A. The Work of this Specification shall not commence until Contractor's demolition plan has been approved by Engineer.
- B. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.
- C. Areas in which the Work is to be accomplished will be available as indicated on the Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED

- A. Facilities: Portions of buildings and other areas scheduled for selective demolition and partial demolition Work are as shown.
- B. Utilities and Related Equipment:
 - 1. Notify Owner or appropriate utilities to turn off affected services at least 48 hours before starting demolition activities.
 - 2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
 - 3. When utility lines are encountered that are not indicated on the Drawings, notify Engineer prior to further work in that area.
 - 4. Remove meters and related equipment and deliver to a location as determined by the Owner.
- C. Masonry: Sawcut and remove masonry so as to prevent damage to surfaces to remain and to facilitate the installation of new Work. Where new masonry adjoins existing, the new Work shall abut or tie into the existing construction as specified.

D. Concrete:

1. Core drill corners of new opening to avoid overcutting adjacent reinforcing in existing concrete to remain. Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the remaining concrete is sound.
2. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Repair exposed rebar ends and embeds as shown on Drawings.
3. Where new concrete adjoins existing concrete, thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 3/16 inch. Rebar and small embeds at existing concrete may be required to be left to engage new concrete. Saturate surface with water for 24 hours prior to placing new concrete. The new Work shall tie into the existing construction as shown on Drawings.

E. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
3. Patching shall be as specified and indicated, and shall include filling holes and depressions caused by previous physical damage or left as a result of removals in existing masonry or concrete walls with an approved patching material, applied in accordance with the manufacturer's printed instructions.

F. Air-conditioning Equipment:

1. Remove air-conditioning equipment without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990.
2. Recover all refrigerants prior to removing air-conditioning equipment and dispose of as specified in Article Specialized Salvage, Paragraph Ozone Depleting Substances (ODS) in Part 3, Execution of this section.

G. Cylinders and Canisters: Remove all fire suppression system cylinders and canisters and dispose as specified in Paragraph Ozone Depleting Substances (ODS) in Part 3, Execution of this section.

H. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.
3. Rework existing circuits, or provide temporary circuits as necessary to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
12. Provide new typewritten panelboard circuit directory cards.

I. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

3.02 PROTECTION

- A. Building Occupancy: Refer to Section 01 31 13, Project Coordination, for specific requirements related to concurrent occupancy of facilities to be partially demolished.
- B. Dust and Debris Control:
1. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

2. Vacuum and dust the Work area daily.
 3. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.
- C. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.
- D. Existing Work:
1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition.
 2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
 3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
 4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
 5. Do not overload pavements to remain.
- E. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.
- F. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by a 6-foot-high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the Work shall be replaced in kind, as approved by the Engineer.
- G. Facilities:
1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.

2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

H. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner's personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner's personnel and the general public to occupied portions of the structure.

3.03 BURNING

- A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.

3.04 RELOCATIONS

- A. Perform removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated that are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.05 BACKFILL

- A. Do not use demolition debris as backfill material.
- B. Fill excavations and other hazardous openings to existing ground level or foundation level as follows:
1. Clean native soils free of rocks can be reused for fill of excavated areas.
 2. Provide clean soil as needed to bring excavated areas back to original grade.
 3. Reseed grassy areas that have been damaged by excavation.

3.06 TITLE TO MATERIALS

- A. All items designated to be removed shall become the property of Contractor.
- B. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Engineer of Contractor's demolition plan, and the resulting authorization by Engineer to begin demolition.

3.07 DISPOSITION OF MATERIAL

- A. Do not remove equipment and materials without approval of Contractor's demolition plan by Engineer.
- B. Remove materials and equipment that are indicated to be removed by Contractor and deliver to a location off the Site.
- C. Owner will not be responsible for the condition or loss of, or damage to, property scheduled to become Contractor's property after Engineer's authorization to begin demolition. Materials and equipment shall not be viewed by prospective purchasers or sold on the Site.

3.08 REUSE OF MATERIALS AND EQUIPMENT

- A. Remove and store materials and equipment listed in Article Title To Materials to be reused or relocated to prevent damage, and reinstall as the Work progresses.
- B. Properly store and maintain equipment and materials in same condition as when removed.
- C. Store equipment and material designated to be reused in a location designated by Owner.
- D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.
- E. Engineer will determine condition of equipment and materials prior to removal.

3.09 SPECIALIZED SALVAGE

- A. Ozone Depleting Substances (ODS):
 - 1. Class I and Class II ODS are defined in Section 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling.

2. Dispose of all Class I and Class II ODS refrigerants in accordance with the Clean Air Act Amendment of 1990.
 3. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g., residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82.
- B. Fire Suppression Containers: Fire suppression system cylinders and canisters with electrical charges or initiators shall be deactivated prior to shipment. Also, safety caps shall be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.10 UNSALVAGEABLE MATERIAL

- A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of off the Site by the Contractor in accordance with all applicable state and local laws.
- B. Combustible material shall be disposed of off the Site by the Contractor in accordance with all applicable state and local laws.
- C. Universal Waste Lamps and Thermostats: Dispose of in strict accordance with 40 CFR 273.

3.11 CLEANUP

- A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 03 01 32
REPAIR OF VERTICAL AND OVERHEAD CONCRETE SURFACES

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. 301, Specifications for Structural Concrete.
 - b. 506.2, Specification for Shotcrete.
2. ASTM International (ASTM):
 - a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
 - g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
 - h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - i. C293/C293M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
 - j. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
 - k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - l. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - m. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
 - n. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - o. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

- p. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
 - q. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
 - r. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
 - s. D4259, Standard Practice for Abrading Concrete.
 - t. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
3. NSF International (NSF): 61, Standard for Drinking Water System Components – Health Effects.

1.02 DEFINITIONS

- A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.
- B. High-pressure Water Blasting: Sometimes referred to as hydro-demolition. Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.
- C. Low-pressure Spray Mortar: Mortar suitable to be applied by low-pressure spraying, and in small areas may be applied by hand troweling.
- D. Rebound: Shotcrete material, mostly aggregates, that bounce off a surface against which shotcrete was projected.
- E. Shotcrete: Mortar pumped through hose and projected at high velocity.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Product data sheets for each material supplied.
 - 2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar for each repair location in existing concrete.
 - 3. Drawings indicating results of sounding for hollow areas including location, size, and estimated quantity of hollow-sounding areas for each repair location.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer's preparation and installation instructions.
2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates:
 - a. Shotcrete Nozzleman: Current ACI Certification for each proposed nozzleman.
 - b. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on vertical and overhead surfaces that are exposed to potable water.
 - c. Mortar Manufacturer's Certificate of Proper Installation.
 - d. Confirmation material is certified to meet requirements of NSF 61.
4. Statements of Qualification:
 - a. Repair mortar system applicator.
 - b. Repair mortar system manufacturer's representative.
 - c. Independent testing laboratory.
5. Repair mortar system manufacturer's proposed modified test procedures for ASTM C109/C109M, ASTM C882/C882M, and ASTM C157/C157M test methods.
6. Field and laboratory test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator:
 - a. For Repair System A – Shotcrete Mortar, trained and experienced applicator recognized or certified by repair mortar system manufacturer.
 - b. For Repair System B – Low-Pressure Spray Mortar, in lieu of recognition or certification, demonstrate application of repair mortar manufacturer's system and obtain Certification of Proper Installation, in accordance with Article Manufacturer's Services.
2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.

C. Demonstration Mockup:

1. Repair Mortar System Manufacturer's Demonstration:
 - a. Schedule time for manufacturer's demonstration of repair system proposed for Project.
 - b. Prepare mortar to specified consistency for testing and placement.
 - c. Cure portions of each type of surface to be repaired using proposed curing procedure and materials, including overhead and vertical applications.
 - d. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
 - e. Demonstrate the following:
 - 1) Mixing and application equipment capabilities and procedures, including flow of material from nozzle or sprayer.
 - 2) Nozzle operator and person in charge of low-pressure sprayer, capabilities and ability to follow prescribed application procedures and properly operate equipment and apply surface repair materials.

D. Where Required by Engineer: Demonstration Mockup for Repair System C – Polymer Modified Repair Mortar System:

1. Repair Mortar System Manufacturer's Demonstration:
 - a. Schedule time for manufacturer's demonstration of repair system proposed for Project.
 - b. Prepare mortar to specified consistency, for testing and placement.
 - c. Cure portions of each type of surface to be repaired using proposed curing procedure and materials, including overhead and vertical applications.
 - d. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
 - e. Demonstrate mixing and application procedures.

E. Pre-repair Conference:

1. Required Meeting Attendees:
 - a. Contractor.
 - b. Repair Subcontractor.
 - c. Technical representative for repair material manufacturer.
 - d. Engineer.
2. Schedule and conduct prior to conducting mockups and incorporation of respective products into Project. Notify Engineer of location and time.

3. Agenda shall include, but not limited to:
 - a. Review of field conditions. Conduct field observations of Work to be performed.
 - b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project-specific repair method recommendations.
 - c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
 - d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.
- B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR SYSTEM A – SHOTCRETE MORTAR

- A. Mortar Materials:
 1. Blend of selected portland cements, microsilica, and specially graded aggregates and fibers applicable for vertical and overhead surfaces.
 2. Materials shall not contain asbestos, chlorides, nitrates, added gypsum, added lime, or high aluminum cements.
 3. Noncombustible before and after cure.
 4. Furnish in factory proportioned unit.
 5. Workability from 1/4 inch in depth and greater.
- B. Mixed Mortar Properties:
 1. Working Time: 5 minutes to 10 minutes.
 2. Finishing Time: 10 minutes to 20 minutes.
 3. Color: Dark gray.
- C. Cured Mortar Properties:
 1. Compressive strength for 2-inch cubes in accordance with ASTM C109/C109M, or 3-inch cubes in accordance with manufacturer's modification to ASTM C109/C109M:
 - a. 7 Days: 6,000 psi minimum.
 - b. 28 Days: 7,000 psi minimum.

2. Flexural Strength (Modulus of Rupture), ASTM C78/C78M or ASTM C348 (Modified) at 28 Days: 1,100 psi minimum.
3. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 400 psi minimum.
4. Chloride-ion Permeability Based on Charge Passed, ASTM C1202: 800 coulombs maximum.
5. Mortar shall not produce a vapor barrier.
6. Certified to meet requirements of NSF 61 for contact with potable water.

D. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 211SP.
2. Sika Corp., Lyndhurst, NJ; SIKACEM 103F.
3. Euclid Chemical Co., Cleveland, OH; Eucoshot F.

2.02 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR

A. One-component, cement-based, fiber-reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.

B. Cured materials mixed in accordance with manufacturer's instructions shall conform to the following criteria:

1. Compressive Strength, ASTM C109/C109M at 28 Days: 6,000 psi minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,100 psi minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent, at 28 Days: 3,000 psi minimum.
4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
5. Drying Shrinkage, ASTM C157/C157M Modified at 28 Days or ASTM C531: 0.1 percent maximum.
6. Chloride-ion Permeability Based on Charge Passed, ASTM C1202: 1,000 coulombs maximum.
7. System shall not produce a vapor barrier.
8. Certified to meet requirements of NSF 61 for contact with potable water.
9. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only addition of water.
10. Free of chlorides and other chemicals causing corrosion.

C. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 488CI.

2. Sika Corp., Lyndhurst, NJ; SikaRepair 224.
3. Euclid Chemical Co., Cleveland, OH; Tamms Structural Mortar.

2.03 REPAIR SYSTEM D – SITE-MIXED PORTLAND-CEMENT MORTAR

A. Mortar Materials:

1. Use same materials as concrete to be repaired with no coarse aggregate, in accordance with Section 03 30 00, Cast-in-Place Concrete. Use of 3/8-inch nominal pea gravel acceptable where repairs are in excess of 1 inch deep.
2. For repairs to exposed concrete, make trial batches to check color compatibility of repair mortar with existing surrounding concrete.
3. When repair is too dark, substitute white portland cement for part of the gray portland cement to produce desired color closely matching color of surrounding concrete.

2.04 WATER

- ### A.
- Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.05 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

- ### A.
- Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.
1. Mixed Bonding Agent Properties:
 - a. Pot Life: 75 minutes to 105 minutes.
 - b. Contact Time: 24 hours.
 - c. Color: Concrete gray.
 2. Cured Cementitious Adhesive Properties:
 - a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 psi minimum.
 - b. Flexural Strength, ASTM C348: 1,000 psi minimum.
 - c. Slant Shear Bond Strength, ASTM C882/C882M at 14 Days:
 - 1) 2-hour Open Time: 2,500 psi minimum.
 - 2) 24-hour Open Time: 2,000 psi minimum.
 3. Bonding agent shall not produce a vapor barrier.
 4. Compatible with and from same manufacturer as the repair system used.
- ### B. Manufacturers and Products:
1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco P 124.

2. Sika Corp., Lyndhurst, NJ; Sika Armatec 110 EpoCem.
3. Euclid Chemical Co., Cleveland, OH: Dural Prep AC.

PART 3 EXECUTION

3.01 GENERAL

- A. Existing Concrete Work: Repair concrete as identified in Contract Documents.

3.02 PREPARATION

- A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer, and review proposed extent of repair with Engineer.
- B. Remove unsound, honeycombed, deteriorated, or otherwise defective areas of concrete from work areas.
 1. Use 8,000 psi minimum high-pressure abrasive blasting machine as required for Site conditions.
 2. For existing structures, extent of concrete removal as shown on Drawings.
- C. Do not use power-driven jackhammers, chipping hammers, or scabblers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.
- D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.
- E. Remove unsound concrete to satisfaction of Engineer.
- F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.
- G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to circumference of exposed steel reinforcement if one or more of the following surface conditions exist:
 1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.

2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
 3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.
- H. Clean exposed steel reinforcement of loose rust and concrete splatter according to recommendations of repair material manufacturer and in accordance with ASTM D4258.
- I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminants from prepared areas.
- J. Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar as required by and in accordance with repair mortar manufacturer's printed instructions.
- K. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

3.03 PROTECTION

- A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.
- B. Protect adjacent surfaces, and equipment, from being damaged by overshooting, rebound, and dust, as applicable for repair mortar system used, from shotcrete mortar or low-pressure spray mortar.

3.04 CURING

- A. Prior to curing, apply water fog to repair mortar system in accordance with repair mortar system manufacturer's printed instructions.
- B. Cure in accordance with repair mortar manufacturer's printed instructions.
- C. Where permitted by repair mortar manufacturer's printed instructions, continue water fog curing after repair mortar system application and when curing will not cause erosion of mortar.
- D. Continuously water fog cure repair mortar system for a period of 7 days.

- E. Do not cure using curing compound or membrane, unless method is part of repair mortar system manufacturer's printed instructions and approval is obtained from Engineer.
- F. Cure intermediate layers of repair mortar in accordance with repair mortar manufacturer's printed instructions.

3.05 MANUFACTURER'S SERVICES

- A. Provide repair mortar system manufacturer's representative at Site to review acceptability of surface preparation, mixing and installation assistance, inspection, and Certification of Proper Installation.

3.06 CLEANING

- A. Remove overshot repair mortar and rebound materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of or repair areas, finishing, and curing, and dispose offsite at an approved disposal site.

END OF SECTION

SECTION 03 01 33
REPAIR OF HORIZONTAL CONCRETE SURFACES

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): T277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
2. ASTM International (ASTM):
 - a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
 - g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
 - h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - i. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
 - j. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
 - k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - l. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - m. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - o. C928/C928M, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.

- p. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
 - q. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
 - r. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
 - s. D638, Standard Test Method for Tensile Properties of Plastics.
 - t. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
 - u. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
 - v. D4259, Standard Practice for Abrading Concrete.
 - w. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
- 3. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40: 52.254, Approval and Promulgation of Implementation Plans.
 - 4. NSF, International (NSF): 61, Standard for Drinking Water System Components – Health Effects.

1.02 DEFINITIONS

- A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.
- B. High-pressure Water Blasting (sometimes referred to as hydro-demolition): Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

1.03 SUBMITTALS

- A. Action Submittals: Product data sheets for each material supplied.
- B. Informational Submittals:
 - 1. Repair Mortar System: Manufacturer's preparation and installation instructions.

2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates:
 - a. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems meet requirements of ASTM C928/C928M.
 - b. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on horizontal surfaces that are exposed to weather or potable water.
 - c. Mortar Manufacturer's Certificate of Proper Installation.
 - d. Confirmation mortar materials meet requirements of NSF 61.
 - e. Confirmation epoxy resin bonding agents conform to ASTM C882//C882M.
4. Statements of Qualification: Repair mortar system applicator.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.
2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Pre-repair Conference:

1. Required Meeting Attendees:
 - a. Contractor.
 - b. Repair subcontractor.
 - c. Technical representative for repair material manufacturer.
 - d. Engineer.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include, but not limited to:
 - a. Review of field conditions. Conduct field observations of the Work to be performed.
 - b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project specific repair method recommendations.

- c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
- d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.
- B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR MORTAR SYSTEM NO. 1—MAGNESIUM PHOSPHATE REPAIR MORTAR

- A. One-component or two-component, magnesium-ammonium-phosphate concrete mortar.
- B. Compressive Strength, ASTM C109/C109M modified:
 - 1. 1 Hour: 2,000 psi minimum.
 - 2. 3 Hours: 5,000 psi minimum.
 - 3. 1 Day: 6,000 psi minimum.
 - 4. 28 Days: 7,500 psi minimum.
- C. Flexural Strength, ASTM C78/C78M Modified (3-inch by 4-inch by 16-inch prism) at 1 Day: 550 psi minimum.
- D. Modulus of Elasticity, ASTM C469 at 7 Days: 4.18 by 10⁶ psi minimum.
- E. Freeze-thaw Resistance and Resistance to Deicing Chemicals, ASTM C666/C666M, Procedure A, at 300 Cycles: 80 percent RDM minimum.
- F. Sulfate Resistance, ASTM C1012/C1012M, Length Change after 52 Weeks: 0.09 percent maximum.
- G. Application Temperature Range: 20 degrees F to 85 degrees F for normal weather applications.
- H. Certified to meet requirements of NSF 61 for contact with potable water.

I. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building System, Shakopee, MN; MasterEmaco T 545.
2. Euclid Chemical Co., Cleveland, OH; Eucospeed MP.

2.02 REPAIR MORTAR SYSTEM NO. 2—HIGH EARLY STRENGTH REPAIR MORTAR

A. One-component or two-component, fast-setting, high early strength repair mortar.

B. Compressive Strength, ASTM C109/C109M:

1. 2 Hours: 1,500 psi minimum.
2. 1 Day: 4,500 psi minimum.
3. 7 Days: 8,000 psi minimum.
4. 28 Days: 9,000 psi minimum.

C. Flexural Strength, ASTM C348:

1. 1 Day: 850 psi minimum.
2. 7 Days: 1,000 psi minimum.
3. 28 Days: 1,100 psi minimum.

D. Modulus of Elasticity, ASTM C469:

1. 1 Day: $3.8 \text{ by } 10^6$ psi minimum.
2. 28 Days: $4.5 \text{ by } 10^6$ psi minimum.

E. Slant Shear Bond Strength, ASTM C882/C882M (Modified):

1. 1 Day: 2,500 psi minimum.
2. 7 Days: 2,900 psi minimum.
3. 28 Days: 3,100 psi minimum.

F. Splitting Tensile Strength, ASTM C496/C496M:

1. 1 Day: 850 psi minimum.
2. 7 Days: 1,200 psi minimum.
3. 28 Days: 1,300 psi minimum.

G. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 98 percent RDM.

H. Chloride-ion Permeability Based on Charge Passed, ASTM C1202 or AASHTO T277, 28 Days: 960 coulombs maximum.

- I. Certified to meet requirements of NSF 61 for contact with potable water.
 - J. Manufacturers and Products:
 - 1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 415.
 - 2. Euclid Chemical Co., Cleveland, OH; VersaSpeed.
- 2.03 REPAIR MORTAR SYSTEM NO. 3—SHRINKAGE COMPENSATED REPAIR MORTAR
- A. One-component or two-component cement-based, flowable, shrinkage compensated repair mortar system.
 - B. Compressive Strength, ASTM C109/C109M:
 - 1. 1 Day: 2,500 psi minimum.
 - 2. 7 Days: 6,000 psi minimum.
 - 3. 28 Days: 8,000 psi minimum.
 - C. Flexural Strength, ASTM C348 at 28 Days: 770 psi minimum.
 - D. Modulus of Elasticity, ASTM C469 at 28 Days: 5.9 by 10⁶ psi minimum.
 - E. Slant Shear Bond Strength, ASTM C882/C882M Modified:
 - 1. 7 Days: 2,150 psi minimum.
 - 2. 28 Days: 3,000 psi minimum.
 - F. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 97.0 percent RDM.
 - G. Chloride-ion Permeability Based on Charge Passed, ASTM C1202 at 28 Days: 650 coulombs maximum.
 - H. Sulfate Resistance, ASTM C1012/C1012M after 6 Months: 0.01 percent length change maximum.
 - I. Certified to meet requirements of NSF 61 for contact with potable water.
 - J. Manufacturers and Products:
 - 1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 466 CI.
 - 2. Euclid Chemical Co., Cleveland, OH; Eucocrete Supreme.

2.04 REPAIR MORTAR SYSTEM NO. 4—METALLIC AGGREGATE REPAIR MORTAR

- A. One-component or two-component cement-based, flowable, metallic-aggregate repair mortar system:
- B. Compressive Strength, ASTM C109/C109M:
 - 1. 1 Day: 5,000 psi minimum.
 - 2. 7 Days: 8,800 psi minimum.
 - 3. 28 Days: 12,000 psi minimum.
- C. Abrasion Resistance, ASTM C779/C779M, Procedure A: Eight times more wear resistance than plain concrete, 0.017 inch maximum.
- D. Density: 215 pound per cubic foot.
- E. Certified to meet requirements of NSF 61 for contact with potable water.
- F. Manufacturers and Products:
 - 1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; Master T 300.
 - 2. Euclid Chemical Co. (The), Cleveland, OH; Super Euco-Top.

2.05 REPAIR MORTAR SYSTEM NO. 5—POLYMER MODIFIED REPAIR MORTAR

- A. One-component or two-component, fast-setting, polymer modified cementitious based repair mortar system.
- B. Compressive Strength, ASTM C109/C109M:
 - 1. 1 Day: 2,500 psi minimum.
 - 2. 7 Days: 5,000 psi minimum.
 - 3. 28 Days: 7,000 psi minimum.
- C. Flexural Strength, ASTM C348 at 28 Days: 1,500 psi minimum.
- D. Slant Shear Bond Strength, ASTM C882/C882M Modified at 28 Days: 2,000 psi minimum.
- E. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
- F. Abrasion Resistance Depth of Wear, ASTM C779/C779M, Procedure A, at 60 Minutes: 0.033 inch maximum.

- G. Drying Shrinkage, ASTM C157/C157M Modified, at 28 Days: 0.09 percent maximum.
- H. Rapid Chloride-ion Permeability Based on Charge Passed, ASTM C1202: 28 Days: Under 850 coulombs maximum.
- I. Certified to meet requirements of NSF 61 for contact with potable water.
- J. Manufacturers and Products:
 - 1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 310 CI.
 - 2. Euclid Chemical Co., Cleveland, OH; Duraltop Flowable Mortar.
 - 3. Sika Corp., Lyndhurst, NJ; SikaTop 122 PLUS.

2.06 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.07 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

- A. Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.
 - 1. Mixed Bonding Agent Properties:
 - a. Pot Life: 75 minutes to 105 minutes.
 - b. Contact Time: 24 hours.
 - c. Color: Concrete gray.
 - 2. Cured Cementitious Adhesive Properties:
 - a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
 - b. Flexural Strength, ASTM C348: 1,000 psi minimum.
 - c. Slant Shear Bond Strength, ASTM C882/C882M:
 - 1) 2-hour Open Time: 2,500 psi minimum.
 - 2) 24-hour Open Time: 2,000 psi minimum.
 - 3. Bonding agent shall not produce a vapor barrier.
 - 4. Compatible with, and from same manufacturer as the, repair mortar system used.
- B. Manufacturers and Products:
 - 1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco P 124.
 - 2. Sika Corp., Lyndhurst, NJ; Sika Armatex 110 EpoCem.
 - 3. Euclid Chemical Co., Cleveland, OH; Dural Prep AC.

2.08 EPOXY BONDING AGENT

- A. Two-component, moisture insensitive, 100 percent solids epoxy resin.
- B. Tensile Strength, ASTM D638, at 14 Days: 4,400 psi minimum.
- C. Elongation at Break, ASTM D638: 1.49 percent minimum.
- D. Compressive Strength, ASTM D695, at 28 Days for Application Temperature of 73 Degrees F to 77 Degrees F: 8,000 psi minimum.
- E. Bond Strength, ASTM C882/C882M, at 14 Days: 1,800 psi minimum.
- F. Pot Life, at 73 Degrees F to 77 Degrees F: 75 minutes minimum.
- G. Manufacturers and Products: BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco ADH 326 when ambient temperature is 73 degrees F or higher.

PART 3 EXECUTION

3.01 GENERAL

- A. Existing Concrete Work: Repair concrete as identified in Contract Documents.

3.02 APPLICATION

- A. General:
 - 1. Repair Mortar System No. 1: Patches, joints, and overlays 1/2 inch to 3 inches thick. Return to service in 1 hour.
 - 2. Repair Mortar System No. 2: Patches, joints, or overlays 1/2 inch to 3 inches thick. Return to service in 3 hours to 7 days.
 - 3. Repair Mortar System No. 3: Patches, joints, or overlays 1 inch thick or greater. Return to service in 7 days or more.
 - 4. Repair Mortar System No. 4: Heavy-duty joints or overlays 2 inches thick or greater. Return to service in 7 days or more.
 - 5. Repair Mortar System No. 5:
 - a. Patches and Overlays: 1/4 inch to 3 inches thick.
 - b. Return to service for foot traffic in 4 hours; wheel traffic in 7 days.
 - c. Working Time: 30 minutes at 70 degrees F.
 - d. Application Temperature Range: 45 degrees F to 90 degrees F.

3.03 PREPARATION

- A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer. Review proposed extent of repair with Engineer.

- B. Remove unsound, deteriorated, or otherwise defective areas of concrete from Work areas.
1. Use 8,000 psi minimum high-pressure abrasive blasting machine, as appropriate to suit Site conditions.
 2. Remove concrete to abrade substrate concrete surface to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
 3. For existing structures, extent of concrete removal as shown on Drawings.
 4. Where final surface is required to be flush with existing adjacent surface, remove existing concrete depth as required for application of minimum thickness of repair mortar.
- C. Do not use power-driven jackhammers, chipping hammers, scabblers, or scarifiers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.
- D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.
- E. Remove unsound concrete to satisfaction of Engineer.
- F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.
- G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to entire circumference of exposed steel reinforcement if one or more of the following surface conditions exist:
1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
 2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
 3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.

- H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.
- I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminants from prepared areas.
- J. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System Nos. 1, 2, 3, and 5: Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar, as required by and in accordance with repair mortar manufacturer's printed instructions.
- K. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System No. 4 Repair Mortar: Dry, in accordance with material manufacturer's printed instructions.
- L. Spalled Joints:
 - 1. Saw cut edge 1 inch deep and 6 inches back from old joint.
 - 2. Remove unsound concrete and concrete between saw cut and joint.
 - 3. Place wood or fiber spacer to thickness of joint at joint line.
- M. Overlays:
 - 1. Square cut edges to a minimum of 1/4 inch deep.
 - 2. Do not feather edge area.
 - 3. Perform special preparation recommended by mortar manufacturer.
- N. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

3.04 PROTECTION

- A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.
- B. Protect adjacent surfaces, and equipment from spillage of repair mortar and dust, as applicable for repair mortar system used.

3.05 PLACEMENT

A. Repair Mortar System Nos. 1, 2, 3, and 5:

1. Remove standing and free water from prepared area.
2. Apply bond scrub coat of mortar to prepared surface in accordance with manufacturer's instructions. Do not apply more scrub coat of mortar than can be covered with repair mortar before scrub coat begins drying.
3. Immediately place mixed repair mortar into prepared area from one side to the other side.
4. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
5. Level repair mortar and screed to elevation of existing concrete.
6. Finish to same texture as existing concrete around patch.
7. Repair Mortar System No. 5 screed or use self-leveling mixture to obtain a uniform and plane surface.

B. Repair Mortar System No. 4:

1. Remove free water from prepared area.
2. Apply bonding agent to prepared surface in accordance with manufacturer's instructions. Do not apply more bonding agent than can be covered with mortar before bonding agent cures, past tacky to the touch.
3. Immediately place mixed repair mortar into prepared area from one side to the other side.
4. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
5. Level repair mortar and screed to elevation of existing concrete.
6. Finish to same texture as existing concrete around patch.

C. Joint Repair:

1. Remove joint spacer when repair mortar is hard enough that a pointed trowel will penetrate surface less than 1/2 inch.
2. When repair mortar is cured and ready for use, fill joint in accordance with repair mortar system manufacturer's instructions.

3.06 FINISHING

- #### A.
1. Spray full strength evaporation retardant on fresh concrete to prevent rapid drying during hot and windy weather.

3.07 CURING

A. Repair Mortar System No. 1:

1. No curing is required.
2. Protect from rain immediately after placing.
3. Liquid-membrane curing compounds or plastic sheeting may be used in accordance with repair mortar manufacturer's instructions to protect the surface from precipitation.
4. Never wet cure.

B. Repair Mortar System Nos. 2, 3, 4, or 5: Apply curing compound in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.08 MANUFACTURERS' SERVICES

A. Provide mortar manufacturer's representative at Site to advice on product selection, review acceptability of surface preparation, mixing and installation assistance, inspection, and Certification of Proper Installation.

3.09 CLEANING

A. Remove excess repair mortar materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of repair areas, finishing, and curing, and dispose offsite at approved disposal site.

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND ACCESSORIES

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. A36/A36M, Specification for Carbon Structural Steel.
 - b. A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - d. A767/A767M, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - e. C920, Specification for Elastomeric Joint Sealants.
 - f. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - g. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
 - h. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - i. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
 - j. D1171, Standard Guide for Evaluating Nonwoven Fabrics.
 - k. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - l. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - m. D2240, Standard Test Method for Rubber Property – Durometer Hardness.
2. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
3. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
2. Product Data:
 - a. Waterstops.
 - b. Epoxy-coated dowels.
 - c. Accessories not specified in other sections.
3. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.

B. Informational Submittals:

1. Certification:
 - a. Letter stating compatibility between liquids being contained and materials used for waterstops.
 - b. Manufacturer's application instructions for bonding agent.
2. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
 - a. Waterstops.
 - b. Bonding agent.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer's product data sheets prior to unloading and storing onsite.
- B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 HYDROPHILIC WATERSTOP

- A. For use at construction joints only, where new concrete is placed against existing concrete and as shown on Drawings.
- B. Material shall be a nonbentonite hydrophilic rubber compound.

C. Manufacturers and Products:

1. Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
2. Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.

PART 3 EXECUTION

3.01 GENERAL

- A. Commence concrete placement after joint preparation is complete.
- B. Time Between Concrete Pours: As specified in Section 03 30 00, Cast-in-Place Concrete.

3.02 SURFACE PREPARATION

- A. Construction Joints: Prior to placement of abutting concrete, clean contact surface.
 1. Remove laitance and spillage from steel reinforcement and dowels.
 2. Roughen surface to minimum of 1/4-inch amplitude:
 - a. Sandblast after concrete has fully cured.
 - b. Water blast after concrete has partially cured.
 - c. Green cut fresh concrete with high-pressure water and hand tools.
 3. Perform cleaning so as not to damage waterstop, if one is present.
- B. Construction Joint with Hydrophilic Waterstop:
 1. Follow hydrophilic waterstop manufacturer's written instructions.
 2. Clean debris, dirt, dust, and foreign material from concrete surface. Concrete surface must be smooth, clean, and dry. Grind concrete as required.

3.03 INSTALLATION OF WATERSTOPS

- A. General:
 1. Continuous waterstop shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
 2. Join waterstop at intersections to provide continuous seal.
 3. Center waterstop on joint.

4. Secure waterstop in correct position. Tie waterstop to steel reinforcement using grommets, "hog rings," or tie-wire at maximum spacing of 12 inches. 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. Joints in Footings and Slabs:
 - a. Ensure that space beneath horizontal waterstop is completely filled with concrete.
 - b. During concrete placement, make visual inspection of waterstop area.
 - c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift ribbed waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Hydrophilic Waterstop:

1. Install in accordance with manufacturer's written instructions.
2. 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.
3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
4. Lap ends of waterstop strip together at splices and corners and join with sealant.
5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.
6. Lap hydrophilic waterstop 2 feet minimum with intersecting plastic waterstops.

3.04 CONTROL JOINT INSTALLATION

- A. Install epoxy-coated steel reinforcement as shown.
- B. Install waterstop.
- C. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

3.05 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

3.06 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 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

- A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI):
 - a. 117, Specification for Tolerances for Concrete Construction and Materials.
 - b. 301, Specifications for Structural Concrete.
 - c. SP-66, Detailing Manual.
 2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
 3. ASTM International (ASTM):
 - a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - c. A767/767M, Standard Specification for Zinc-Coated (Galvanized) Steel bars for Concrete Reinforcement
 - d. A775/A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
 - e. A1064/A1064M, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 4. Concrete Reinforcing Steel Institute (CRSI):
 - a. Placing Reinforcing Bars.
 - b. Manual of Standard Practice.
 5. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66:
 - a. Bending lists.
 - b. Placing drawings.
 2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
 - a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
 - b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer's published methods.
 - c. Manufacturer's instructions.
3. Epoxy-coated Reinforcing Bars: Written certification in accordance with Paragraph 14.1 of ASTM A775/A775M.
4. Test results of field testing.

1.04 QUALITY ASSURANCE

- A. Welder Qualifications:** Certified in accordance with AWS D1.4/D1.4M.

1.05 DELIVERY, STORAGE, AND HANDLING

- A.** In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.
- B. Epoxy-coated Reinforcing Bars:**
1. Protect contact areas of epoxy-coated bars from handling equipment.
 2. Lift bundles of bars at multiple pickup points to minimize bar-to-bar abrasion from sags in bundles.
 3. Do not drop or drag bars or bundles of bars.
 4. Store bars on protective cribbing.
 5. Color fading of coating is not cause for rejection of epoxy-coated reinforcing bars.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Reinforcing Bars:**
1. Includes stirrups, ties, and spirals.
 2. ASTM A615/A615M, Grade 60, where welding is not required.
 3. ASTM A706/A706M, Grade 60, for reinforcing to be welded.
 4. ASTM A767/767M, Grade 60, for galvanized bars.
 5. ASTM A775/A775M, for epoxy-coated bars.

B. Mechanical Splices and Connections:

1. Metal Sleeve Splice:
 - a. Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
 - b. Manufacturer and Product: Erico Products, Inc., Cleveland, OH; Cadweld T-Series.
2. Mechanical Threaded Connections:
 - a. Furnish metal coupling sleeve with internal threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.
 - b. Manufacturers and Products:
 - 1) Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
 - 2) Erico Products, Inc., Cleveland, OH; Lenton Lock Mechanical Rebar Splicing System.
 - 3) Richmond Screw Anchor Co., Inc., Fort Worth, TX; Richmond DB-SAE Dowel Bar Splicers.

C. Welded Wire Fabric:

1. ASTM A1064, using wire of 75 ksi minimum tensile strength.
2. Furnish flat sheets only, rolled sheets not permitted.

2.02 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Use precast concrete bar supports or all-plastic bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. 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.
3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to

be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to steel reinforcement.

5. In Beams, Columns, Walls, and Slabs Exposed to View after Form Removal: Use small precast concrete blocks made of same color as concrete in which they are embedded. All-plastic bar supports and side form spacers may be used, except where surface is exposed as described above.
6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.
7. Use supports made of dielectric material for epoxy-coated reinforcing bars supported from formwork.
8. If epoxy-coated reinforcing is used, furnish epoxy-coated reinforcing bars for spreader bars.
9. Plastic Bar Supports: Manufactured by Aztec Concrete Accessories, Bloomington, CA.
10. Precast Concrete Supports: Total bond precast, high-performance concrete bar supports as supplied by: Dayton Superior, Miamisburg, OH; Dobies.

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.
- B. Repair epoxy coating damaged as a result of handling, shipment, and placing. Repair with patching material in accordance with ASTM A775/A775M and manufacturer's recommendations.
- C. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.
- D. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.02 INSTALLATION

- A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.

B. Splicing:

1. Minimum length of lap splices shall comply with Contract Documents.
2. Use lap splices, unless otherwise shown or permitted in writing by Engineer.
3. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
4. Stagger splices in adjacent bars where indicated.

C. Mechanical Splices and Connections:

1. Use only in areas specifically approved in writing by Engineer.
2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
3. For metal sleeve splice, follow manufacturer's installation recommendations.
4. Maintain minimum edge distance and concrete cover.

D. Tying Reinforcing Bars:

1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.
3. Epoxy-coated Reinforcing Bars:
 - a. Use epoxy-coated or nonmetallic clips.
 - b. Repair coating damage at clipped or welded intersections.

E. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.

F. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.

G. Unless permitted by Engineer, do not cut reinforcing bars in field.

3.03 WELDED WIRE FABRIC INSTALLATION

A. Use only where specifically shown.

B. Extend fabric to within 2 inches of edges of slab and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.

C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.

- D. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.
- E. Do not use fabric that has been rolled. Install flat sheets only.

3.04 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 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.03 DEFINITIONS

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

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.*
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
- *Contractor shall engage an independent testing agency to perform all tests and quality assurance inspections and reports outlined in this Specification. The Contractor shall submit the qualifications of the designated testing agency to the Commission for approval prior to the preinstallation conference. All costs associated with the work performed by the testing agency shall be paid for by the Contractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.05 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
2. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - a. Indicate amounts of mixing water to be withheld for later addition at Project Site.
3. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
4. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Engineer.

B. Informational Submittals:

1. Qualification Data: For installer, manufacturer, testing agency.
2. Material Certificates: For each of the following, signed by manufacturers.
 - a. Cementitious materials.
 - b. Admixtures.
 - c. Form materials and form-release agents.
 - d. Steel reinforcement and accessories.
 - e. Curing compounds.
 - f. Bonding agents.
 - g. Adhesives.
 - h. Vapor retarders.
 - i. Repair materials.
3. Material Test Reports: For aggregates, from a qualified testing agency.
4. Field quality-control reports.
5. Minutes of preinstallation conference.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

1.07 PRECONSTRUCTION TESTING

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

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1.09 FIELD CONDITIONS

- A. Cold-weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 degrees F for 3 successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-weather Placement: Comply with ACI 301 and as follows.
1. Maintain concrete temperature below 90 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 PRODUCTS

2.01 CONCRETE, GENERAL

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

2.02 FORM-FACING MATERIALS

- A. Rough-formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- B. Chamfer Strips: Wood, metal, polyvinyl chloride (PVC), or rubber strips, 3/4 inch by 3/4 inch, minimum.
- C. Form-release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

2.03 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 1. Portland Cement: ASTM C150/C150M, Type I or Type II, gray.
 2. Fly Ash: ASTM C618, Class F.
 3. Blended Hydraulic Cement: ASTM C595/C595M, Type IP, portland-pozzolan cement.
- C. Normal-weight Aggregates: ASTM C33/C33M, coarse aggregate or better, graded. Provide aggregates from a single source.
 1. Maximum Coarse-aggregate Size: 1-1/2 inches nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 1. Water-reducing Admixture: ASTM C494/C494M, Type A.
 2. Retarding Admixture: ASTM C494/C494M, Type B.
 3. Water-reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 4. High-range, Water-reducing Admixture: ASTM C494/C494M, Type F.
 5. High-range, Water-reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- F. Water: ASTM C94/C94M and potable.

2.04 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E1745, Class C, not less than 10 mils. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2.05 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard when dry.
- C. Moisture-retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

2.06 RELATED MATERIALS

- A. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.07 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 inch to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4,100 psi at 28 days when tested according to ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 inch to 1/4 inch or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5,000 psi (at 28 days when tested according to ASTM C109/C109M).

2.08 CONCRETE MIXTURES, GENERAL

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

2.09 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Slabs-on-grade: Normal-weight concrete.
 1. Minimum Compressive Strength: As indicated at 28 days.
 2. Maximum W/C Ratio: 0.45.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
 4. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.10 FABRICATING REINFORCEMENT

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

2.11 CONCRETE MIXING

- A. Ready-mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.
 1. When air temperature is between 85 degrees F and 90 degrees F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air

temperature is above 90 degrees F, reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.01 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8-inch for smooth-formed finished surfaces.
 - 2. Class C, 1/2-inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.03 VAPOR-RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.04 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.05 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project Site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.06 FINISHING FORMED SURFACES

- A. Rough-formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.07 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in

texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view.
 2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-foot-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 3/16 inch.
- D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.08 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.09 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2-pound per square foot times height before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials.
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-retaining-cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than 7 days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

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

Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.11 FIELD QUALITY CONTROL

- A. Testing: Contractor shall engage a qualified testing agency to perform field tests and prepare test reports.
- B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements.
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cubic yards, but less than 25 cubic yards, plus one set for each additional 50 cubic yards or fraction thereof.
 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C231/C231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 degrees F and below or 80 degrees F and above, and one test for each composite sample.
 5. Unit Weight: ASTM C567/C567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

6. Compression Test Specimens: ASTM C31/C31.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
10. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by the Engineer.
13. Additional testing, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

SECTION 03 53 00
STANDARD-SIZED EPS BLOCKS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions, and Division 1 Specification sections and manufacturer's shop drawings apply to this section.

1.02 SUMMARY

- A. Provide EPS geofoam blocks that have been factory-fabricated to fit Project dimensions minimizing field cutting and Site-generated waste.
- B. Related Sections: Division 3 Section 03 30 00, Cast-in-Place Concrete for concrete reinforcing and slabs poured on top of permanent riser forms.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide molded, rigid cellular polystyrene EPS geofoam blocks. Comply with manufacturer's requirements, ASTM D6817, or ASTM C578.
 - 1. Design Loads: As indicated.

1.04 SUBMITTALS

- A. Shop Drawings: Show layout and dimensions of each geofoam fill area. Indicate location, size, and elevation. Provide cross-section of each platform area indicating height and depth of each fill area. Provide plan view of each layer of EPS with each part identified and dimensioned according to the Geofoam Component Schedule.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protection of Geofoam EPS Block:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect against ignition at all times.
 - 3. Do not deliver EPS materials to Project Site before installation time.
 - 4. Complete installation and concealment of EPS materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Available Manufacturers: Subject to compliance with requirements, assembly methods that may be incorporated into the Work include the following:

Geofoam International LLC
9325 Sky Park Court, Suite 250
San Diego, CA 92123
Phone: 844.773.3626
Web: info@geofoamintl.com
www.geofoamintl.com

2.02 MATERIALS

- A. Molded, rigid cellular polystyrene EPS geofoam blocks. Comply with manufacturer's requirements, ASTM D6817, or ASTM C578.

2.03 FABRICATION

- A. Fabricate EPS blocks, square, and true to dimension.
1. Factory cut block for delivery to jobsite and installation without the need for excessive field cutting.
 2. Retrofit Projects: Fabricate block with slope consistent to existing floor slope.
 3. Ramp Areas: Fabricate block with slope consistent with ramp slope requirements.
- B. Marking and Identification: Individual geofoam EPS blocks shall be marked corresponding to shop drawings for installation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for elevations, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been correct.

3.02 GENERAL INSTALLATION

- A. Install system in compliance with Architect's plans and installation/shop drawings as prepared by manufacturer.

B. EPS Geofoam Block Installation: Install blocks in layers and locations as specified on shop drawings. Hold dimensions on shop drawings and Architect's plans.

1. Place non-solvent-based adhesive between each layer of EPS to tack in place during assembly.

Note: Do not weld with torch in the same room as installed or stored EPS. Protect EPS against ignition at all times.

END OF SECTION

SECTION 03 62 00 GROUTING

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. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - b. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
 - c. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - d. C579, Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
 - f. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - g. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
 - h. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - i. C1181, Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
 - j. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing nonshrink grout.

3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer's Written Instructions:
 - a. Adding fiber reinforcing to batching.
 - b. Mixing of grout.
2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements.
 - a. Grout free from chlorides and other corrosion-causing chemicals.
 - b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Manufacturer's Certificate of Proper Installation.
5. Statements of Qualification: Grout manufacturer's representative.
6. Test Reports:
 - a. Test report for 24-hour evaluation of nonshrink grout.
 - b. Test results and service report from demonstration and training session.
 - c. Field test reports and laboratory test results for field-drawn Samples.
7. List of Contractor's equipment installation staff trained by grout manufacturer's representative in:
 - a. Nonshrink grout installation and curing.
 - b. Epoxy grout installation and curing.

1.03 QUALIFICATIONS

- A. Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.
- B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Provide independent testing laboratory test results for testing conducted within last 18 months.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT AND EPOXY GROUT SCHEDULE

- A. Furnish nonshrink grout (Category I, II, and III) and epoxy grout for applications as indicated in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Blockouts for gate guides	I or II		II
Precast joints	I or II		II
Column baseplates single-story	I or II		II
Machine bases 25 hp or less	II	II	II
Bases for precast wall sections	II	II	II
Baseplates for columns over one story	II	II	II
Precast base joints higher than one story	II	II	II
Form tie-through bolt openings	II	II	II
Machine bases 26 hp and up	III or epoxy grout	III or epoxy grout	III or epoxy grout
Baseplates and/or soleplates with vibration, thermal movement, etc.	III or epoxy grout	III or epoxy grout	III or epoxy grout

2.02 NONSHRINK GROUT

- A. Category I:
1. Nonmetallic and nongas-liberating.
 2. Prepackaged natural aggregate grout requiring only the addition of water.
 3. Test in accordance with ASTM C1107/C1107M:
 - a. Grout shall have flowable consistency.
 - b. Flowable for 15 minutes.
 4. Grout shall not bleed at maximum allowed water.

5. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
 - a. BASF Building System, Inc., Shakopee, MN; MasterFlow 100.
 - b. Euclid Chemical Co., Cleveland, OH; NS Grout.
 - c. Dayton Superior Corp., Miamisburg, OH; 1107 Advantage Grout.
 - d. US MIX Co., Denver, CO; US SPEC GP Grout.
 - e. Five Star Products Inc., Fairfield, CT; Five Star Grout.

B. Category II:

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 90 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 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. BASF Building Systems, Inc., 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.
 - e. US MIX Co., Denver, CO; US SPEC MP Grout.

C. Category III:

1. Metallic and nongas-liberating.
2. Prepackaged 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 and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.

6. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturer and Product:
 - a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 885.
 - b. Euclid Chemical Co, Cleveland, OH; Hi-Flow Metallic Grout.

2.03 EPOXY GROUT

- A. High-strength, nonshrink, high-temperature epoxy grouting material developed for the support of heavy equipment with vibratory loads.
- B. Three-component mixture of a two-component epoxy resin system (100 percent solids) with a graded, precision aggregate blend.
- C. Premeasured, prepackaged system.
- D. Flowable.
- E. Minimum compressive strength in accordance with ASTM C579 Method B, 9,500 psi at 75 degrees F at 7 days, 11,000 psi at post cure.
- F. Maximum creep resistance in accordance with ASTM C1181 at 600 psi, 140 degrees F; 6.0×10^{-3} in/in.
- G. Minimum bond strength in accordance with ASTM C882, 2,000 psi.
- H. Minimum tensile strength in accordance with ASTM C307, 2,000 psi.
- I. Maximum coefficient of thermal expansion in accordance with ASTM C531 at 73 degrees F to 210 degrees F, 23.0×10^{-6} in/in/degrees F.
- J. Working Time: Minimum 2 hours at 50 degrees F; 1.5 hours at 70 degrees F; 50 minutes at 90 degrees F.
- K. Good chemical resistance.
- L. Good effective bearing area.
- M. Noncorrosive.
- N. Moisture insensitive.
- O. Modify resin and aggregate content where recommended by epoxy grout manufacturer to provide desired epoxy grout flow properties.

P. Manufacturer and Product:

1. BASF Building System, Inc., Shakopee MN; MasterFlow 648.
2. Euclid Chemical Co., Cleveland, OH; E³-G.
3. Dayton Superior Corp., Miamisburg, OH; Pro-Poxy 2000 normal set.
4. Five Star Products Inc., Fairfield, CT; DP Epoxy grout.

PART 3 EXECUTION

3.01 GROUT

- A. General: Mix, place, and cure grout in accordance with grout manufacturer's representative's training instructions.
- B. Epoxy Grout: Concrete slab shall be fully cured for 28 days to ensure excess water has evaporated. Test concrete surface for moisture in accordance with ASTM D4263 before epoxy grout is placed.

3.02 GROUTING MACHINERY FOUNDATIONS

- A. 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.
- B. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.
- C. Sandblast to bright metal all metal surfaces in contact with epoxy grout in accordance with manufacturer's written instructions.
- D. 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.
- E. Form with watertight forms at least 2 inches higher than bottom of plate.
- F. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.
- G. If grout cannot be placed from one edge and flowed to the opposite edge, air vents shall be provided through the plate to prevent air entrapment.
- H. Radius all corners of grout pad.
- I. Install expansion joints for epoxy grout placement in accordance with manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

A. General:

1. Performed by Project representative's inspection staff.
2. Perform the following quality control inspections. The grout manufacturer's representative shall accompany the Project representative's inspection staff on the first installation of each size and type of equipment.

B. Evaluation and Acceptance of Nonshrink Grout:

1. Inspect the surface preparation of concrete substrates onto which nonshrink grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
2. Inspect preparation and application of nonshrink grout form work for conformance to the manufacturer's recommendations.
3. Conduct a final review of completed nonshrink grout installation for conformance to these Specifications.
4. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
5. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
6. For large grout applications, make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
7. Consistency: As specified in Article Nonshrink Grout. Flow cone test in accordance with ASTM C939. Grout with consistencies outside range requirements shall be rejected.
8. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
9. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
10. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
11. Perform bleeding test in accordance with ASTM C940 to demonstrate grout will not bleed.
12. Store cubes at 70 degrees F.
13. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.

14. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

C. Evaluation and Acceptance of Epoxy Grout:

1. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
2. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
3. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
4. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
5. Inspect preparation and application of epoxy grout form work for conformance to the manufacturer's recommendation.
6. Verify consistency obtained is sufficient for the proper field placement at the installed temperatures.
7. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during the installation.
8. Inspect epoxy grout for cure.
9. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
10. Conduct a final review of completed epoxy grout installation for conformance to these Specifications.
11. Compression tests and fabrication of specimens for epoxy grout shall be made in accordance to ASTM C579, Method B, at intervals during construction as selected by the Project representative. A set of three specimens shall be made for testing at 7 days, and each earlier time period as appropriate.
12. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C579.
13. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

END OF SECTION

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. International Code Council (ICC):
 - a. 2009 International Building Code (IBC).
 - b. Evaluation Services Reports.
 4. 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.
 2. Samples: Two random samples of each batch of products delivered to Site, for independent testing.
- 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.

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 according to manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to 2009 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
2. Suitable for long-term loads as well as for wind and seismic 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 runoff.
7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
8. Potable Water Structures: Adhesive shall be acceptable for use by NSF 61.

9. 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:
 1. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
 2. Nonremovable internal static mixer required to ensure proper blending of components.
- C. Reinforcing Dowels: As specified in Section 03 21 00, Steel Reinforcement.

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 according to details shown on 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.
 4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.

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. Dispensing, Metering, and Mixing Adhesive Components: Use portable, automatic metering and mixing device or machine capable of maintaining prescribed mix ratio within deviation of 5 percent or less, by volume.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Testing of Automatic Metering and Mixing Devices:

1. Test for Proper Ratio:
 - a. Retain small amount of dispensed adhesive for inspection after each time pump is refilled.
 - b. Check samples for color change.
 - c. Should change in color occur, follow manufacturer's service instructions to obtain proper operation.
2. Frequency of Tests: Make full ratio check after each 100 gallons of adhesive is dispensed or if color of mixed adhesive becomes noticeably darker or lighter.
3. Ratio Check Procedure:
 - a. Disconnect dispensing head behind ON/OFF valve.
 - b. Place volume containers of required proportions under "B" and "A" component hose ends.
 - c. Actuate pump.
 - d. Both cups should fill in an equal time to proper volume, thereby verifying proportion ratio by volume.
 - e. Document timing and results of each ratio check procedure.

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

END OF SECTION

SECTION 03 64 30
CONCRETE REHABILITATION—EPOXY INJECTED CRACK REPAIR

PART 1 GENERAL

1.01 SUMMARY

- A. This specification describes the pressure injection of cracks with an epoxy resin adhesive.

1.02 QUALITY ASSURANCE

- A. Manufacturing Qualifications: The manufacturer of the specified product shall be ISO 9001/9002 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.
- B. Contractor Qualifications: Contractor shall be qualified in the field of concrete repair and protection with a successful track record of 5 years or more. Contractor shall maintain qualified personnel who have received product training by a manufacturer's representative.
- C. Install materials in accordance with all safety and weather conditions required by the manufacturer, or as modified by applicable rules and regulations of local, state and federal authorities having jurisdiction. Consult material safety data sheets (MSDS) for complete handling recommendations.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.
- B. Store all materials off the ground and protect from rain, freezing, or excessive heat until ready for use.
- C. Condition the specified product as recommended by the manufacturer.

1.04 JOB CONDITIONS

- A. Environmental Conditions: Do not apply material if it is raining or snowing, or if such conditions appear to be imminent. Minimum application temperature 40 degrees F (5 degrees C) and rising.
- B. Protection: Precautions should be taken to avoid damage to any surface near the work zone due to mixing and handling of the specified product.

1.05 SUBMITTALS

- A. Informational Submittals: Submit two copies of manufacturer's literature, to include product data sheets and appropriate MSDS.

1.06 WARRANTY

- A. Provide a written warranty from the manufacturer against defects of materials for a period of 1 year, beginning with date of substantial completion of the Project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio 43302.
 - 1. Sikadur 35 Hi-Mod LV products conforming to the requirements of this Specification.
 - 2. Sikadur 31 Hi-Mod Gel products conforming to the requirements of this Specification.

2.02 MATERIALS

- A. Epoxy resin adhesive for pressure injection of cracks shall be Sikadur 35 Hi-Mod LV:
 - 1. Component "A" shall be a modified epoxy resin of the diglycidether bisphenol A type or containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
 - 2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidether bisphenol A type containing suitable viscosity control agents, pigments, and accelerators.
 - 3. Ratio of component A:component B shall be 2:1 by volume.
 - 4. Material shall not contain asbestos.
- B. Epoxy resin adhesive for sealing of cracks and porting devices shall be Sikadur 31 Hi-Mod Gel.
 - 1. Component "A" shall be a modified epoxy resin of the diglycidether bisphenol A type or containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
 - 2. Component "B" shall be primarily a reaction product of a selected amine blend with an epoxy resin of the diglycidether bisphenol A type containing suitable viscosity control agents, pigments, and accelerators.
 - 3. Ratio of component A:component B shall be 1:1 by volume.
 - 4. Material shall not contain asbestos.

- C. Porting devices as required for either manual or automated application. Porting devices for automated application shall be supplied from manufacturer of the pressure injection equipment.

2.03 PERFORMANCE CRITERIA

A. Properties of mixed epoxy resin adhesive used for pressure injection grouting:

1. Pot Life: Minimum 25 minutes (60 gram mass) at 73 degrees F.
2. Tack-free Time:
 - a. 90 Degrees F (32 Degrees C): 1.5 hours to 2 hours.
 - b. 75 Degrees F (24 Degrees C): 3 hours to 3.5 hours.
 - c. 40 Degrees F (5 Degrees C): 14 hours to 16 hours.
3. Viscosity: Approximately 375 cps.
4. Color: Clear, amber.

B. Properties of cured epoxy resin adhesive used for pressure injection of grout:

1. Compressive Strength (ASTM D695), Minimum:
 - a. 3-day: 10,000 psi (69.9 Mpa).
 - b. 7-day: 11,000 psi (75.8 Mpa).
 - c. 28-day: 13,000 psi (89.6 Mpa).
2. Compressive Modulus, psi:
 - a. 7-day: 320,000 psi (2,200 Mpa) minimum.
3. Shear Strength (ASTM D732):
 - a. 14-day: 5,100 psi (35 Mpa) minimum.
4. Flexural Strength (ASTM D790):
 - a. 14-day: 14,000 psi (97 Mpa) minimum.
5. Tangent Modulus of Elasticity in Bending:
 - a. 14-day: 370,000 psi (2,600 Mpa) minimum.
6. Bond Strength (ASTM C882): 14 days (moist cure) minimum.
 - a. Hardened Concrete to Hardened Concrete: 2,900 psi (15 Mpa).
7. Water Absorption (ASTM D570):
 - a. 24-hour: 0.90 percent maximum.
8. Tensile Properties, Minimum (ASTM D638):
 - a. 7-day Tensile Strength: 8,900 psi (61 Mpa).
 - 1) Elongation at Break: 5.4 percent.
 - b. 14-day Modulus of Elasticity: 4.1 times 10⁵ psi (2,800 Mpa).

C. Properties of mixed epoxy resin adhesive used for sealing of cracks and porting devices:

1. Pot Life: Minimum 60 minutes (500 gram mass) at 73 degrees F.
2. Tack-free Time at 73 Degrees F (23 Degrees C): 1.5 hours to 2.5 hours at 30 mils thick.
 - a. Consistency: Non-sag paste.
3. Color: Concrete gray.

- D. Properties of cured epoxy resin adhesive used for sealing of cracks and porting devices:
1. Compressive Strength (ASTM D695), Minimum at 73 Degrees F:
 - a. 1-day: 13,000 psi (89.6 Mpa).
 - b. 3-day: 14,000 psi (96.5 Mpa).
 - c. 28-day: 16,000 psi (110.3 Mpa).
 2. Compressive Modulus, psi:
 - a. 7-day: 795,000 psi (5,485 Mpa) minimum.
 3. Shear Strength (ASTM D732):
 - a. 14-day: 4,600 psi (31,7 Mpa).
 4. Flexural Strength (ASTM D790):
 - a. 14-day: 6,100 psi (42 Mpa) minimum.
 5. Tangent Modulus of Elasticity in Bending:
 - a. 14-day: 1.67 psi times 10^6 psi (11,520 Mpa) minimum.
 6. Bond Strength (ASTM C882): 14 days (moist cure) minimum.
 - a. Hardened Concrete to Hardened Concrete: 2,900 psi (20 Mpa).
 7. Water Absorption (ASTM D570):
 - a. 24-hour: 0.79 percent maximum.
 8. Tensile Properties, Minimum (ASTM D638):
 - a. 7-day Tensile Strength: 3,300 psi (22.7 Mpa).
 - 1) Elongation at Break: 0.9 percent.

Note: Tests above were performed with material and curing conditions at 73 degrees F and 45 percent to 55 percent relative humidity.

PART 3 EXECUTION

3.01 MIXING AND APPLICATION

- A. Mixing epoxy resin adhesive for sealing cracks and porting devices: Premix each component. Proportion equal parts by volume of component “A” and component “B” into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400 rpm to 600 rpm) drill. Mix only that quantity of material that can be used within its pot life (60 minutes at 73 degrees F).
- B. Mixing of epoxy resin adhesive used for pressure injection grouting:
1. Manual: Proportion two parts by volume of component “A” to one part component “B” into a clean, dry mixing pail. Mix thoroughly for 3 minutes with a jiffy paddle on a low-speed (400 rpm to 600 rpm) drill. Mix only that quantity of material that can be used within its pot life (20 minutes to 30 minutes at 73 degrees F).

C. Placement Procedure:

1. Epoxy Resin Adhesive for Sealing Cracks and Porting Devices: Set porting devices as required by equipment manufacturer. Spacing of porting devices shall be accomplished as required to achieve the travel of epoxy resin for pressure injection grouting between ports and fill cracks to maximum. On structures open on both sides, provide porting devices on opposite sides at staggered elevations. Apply mixed epoxy resin adhesive for sealing over cracks and around each porting device to provide an adequate seal to prevent escape of epoxy resin adhesive for injection grouting. Where required by the Engineer, apply epoxy resin adhesive for sealing in such a manner that minimal defacing or discoloration of the substrate shall result.
 2. Epoxy Resin Adhesive for Pressure Injection Grouting:
 - a. Manual: Load mixed epoxy resin adhesive for grouting into a disposable caulking cartridge or bulk-loading caulking gun. Inject prepared cracks with a constant pressure in order to achieve maximum filling and penetration without the inclusion of air pockets or voids in epoxy resin adhesive. Begin pressure injection at the widest part of the crack being injected and continue until there is the appearance of epoxy resin adhesive at an adjacent port, thus indicating travel. When travel is indicated, to discontinue or continue the pressure injection from that port should be made by the Contractor based on experience, with approval of the Engineer. Continue procedure until pressure injectable cracks have been filled.
 - b. Automated: Dispense epoxy resin adhesive for grouting under constant pressure in accordance with procedures recommended by the equipment manufacturer as required to achieve maximum filling and penetration of prepared cracks without the inclusion of air pockets or voids in epoxy resin adhesive. Pressure injection of single or multiple ports, by use of a manifold system, is possible. This decision should be made by the Contractor, with approval of the Engineer. Continue the approved procedure until all pressure injectable cracks have been filled.
- D. If penetration of any cracks is impossible, consult the Engineer before discontinuing injection procedure. If modification of the proposed procedure is required to fill the cracks, submit said modification in writing to the Engineer for acceptance prior to proceeding.
- E. Adhere to all limitations and cautions for the epoxy resin adhesive in the manufacturer's current printed literature.

3.02 CLEANING

- A. After epoxy resin adhesive for grouting has cured, the epoxy resin adhesive for sealing cracks and porting devices shall be removed as required by the Engineer. Clean substrate in a manner to produce a finish appearance acceptable to the Owner.
- B. Uncured epoxy resin adhesive can be cleaned from tools with approved solvent. The cured epoxy resin adhesive can only be removed mechanically.
- C. Leave finished Work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

3.03 SUPPLEMENTS

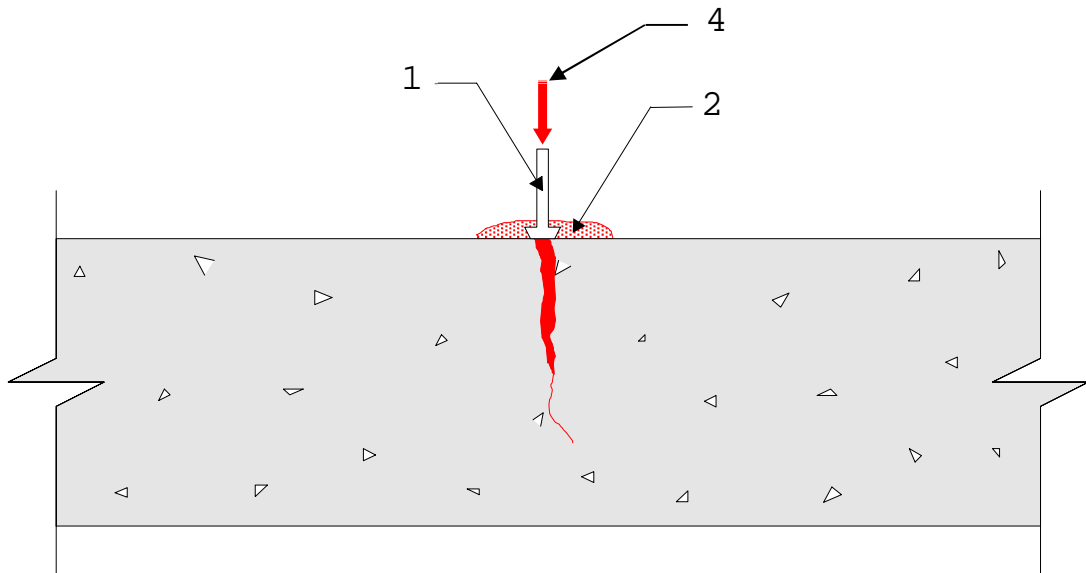
- A. The supplement listed below, following “End of Section,” is part of this specification.
 - 1. SC001: Sikadur 35, Hi-Mod LV Crack Filler; Sikadur 31, Hi-Mod Gel Cap Seal.

END OF SECTION

SC001

Sikadur 35, Hi-Mod LV Crack Filler

Sikadur 31, Hi-Mod Gel Cap Seal



1. Set porting devices over cracks.
2. Place mixed Sikadur 31, Hi-Mod Gel epoxy resin adhesive over cracks and around each injection port a minimum of 1" wide by 1/4" thick.
3. Allow sufficient time for epoxy resin adhesive cap seal to set before injecting.
4. When the cap seal has cured, inject Sikadur 35, Hi-Mod LV with steady pressure.
5. Use automated injection equipment or manual method.

Concrete Restoration Systems by Sika Corporation, 201 Polito Avenue, Lyndhurst, NJ 07071

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. A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A143, Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - c. A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
 - f. A380, Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - g. A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
 - h. A563, Specification for Carbon and Alloy Steel Nuts.
 - i. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - j. A967, Specification for Chemical Passivation Treatments for Stainless Steel Parts.
 - k. E488, Standard Test Methods for Strength of Anchors in Concrete Elements.
 - l. F436, Specification for Hardened Steel Washers.
 - m. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
 - n. F568M, Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

- o. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- p. F594, Specification for Stainless Steel Nuts.
- q. 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.

- E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

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 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:

- 1. 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.
- 2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package stainless steel items in a manner to provide protection from carbon impregnation.
- B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

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
Carbon Steel:	
Threaded rods	F1554, Grade 36 or F568M Class 5.8 A193/A193M, Grade B7
Flat and beveled washers (hardened)	F436
Nuts*	A194/A194M, Grade 2H
Galvanized Steel:	
All	A153/A153M
*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, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Drawings.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Drawings.
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. Undercut Anchors:
1. Manufacturers and Products:
 - a. USP Structural Connectors, Burnsville, MN; DUC Undercut Anchor (ESR-1970).
 - b. Hilti, Inc., Tulsa, OK; HDA undercut anchor (ESR-1546).
 - c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; TORQ-CUT self-undercutting anchor (ESR-2705).
 - d. DeWalt/Powers Fasteners, Brewster, NY; Atomic+ undercut anchor (ESR-3067).
- D. 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).
- E. Adhesive Anchors:
1. Threaded Rod:
 - a. Diameter as shown on 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).

F. 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.

PART 3 EXECUTION

3.01 CONCRETE ANCHORS

- A. Begin installation only after concrete 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 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 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.
 - d. Do not disturb anchor during recommended curing time.
 - e. Do not exceed maximum torque as specified in manufacturer's instructions.
- I. Prestressed Concrete: Do not use drilled-in anchors in prestressed or post-tensioned concrete members without Engineer's prior approval unless specifically shown on Drawings.

3.02 FIELD 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 Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-installed Anchors for Metal Components to Cast-in-place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
Interior dry areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment)	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

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 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Galvanizers Association (AGA): Quality Assurance Manual.
2. American Institute of Steel Construction (AISC):
 - a. 201, Certification Program for Structural Steel Fabricators.
 - b. 206, Certification Program for Structural Steel Erectors—
Standard for Structural Steel Erectors.
 - c. 303, Code of Standard Practices for Steel Buildings and Bridges.
 - d. 325, Steel Construction Manual.
 - e. 326, Detailing for Steel Construction.
 - f. 341, Seismic Provisions for Structural Steel Buildings.
 - g. 360, Specification for Structural Steel Buildings.
 - h. 420, Certification Standard for Shop Application of Complex
Protective Coating Systems.
3. American Welding Society (AWS):
 - a. D1.1/D1.1M, Structural Welding Code—Steel.
 - b. D1.8/D1.8M, Structural Welding Code—Seismic Supplement.
4. ASTM International (ASTM):
 - a. A6/A6M, Standard Specification for General Requirements for
Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 - b. A36/A36M, Standard Specification for Carbon Structural Steel.
 - c. A53/A53M, Standard Specification for Pipe, Steel, Black and
Hot-Dipped, Zinc-Coated Welded and Seamless.
 - d. A123/123M, Standard Specification for Zinc (Hot-Dip
Galvanized) Coatings on Iron and Steel Products.
 - e. A143/A143M, Standard Practice for Safeguarding Against
Embrittlement of Hot-Dip Galvanized Structural Steel Products
and Procedure for Detecting Embrittlement.
 - f. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip)
on Iron and Steel Hardware.
 - g. A325, Standard Specification for Structural Bolts, Steel, Heat
Treated, 120/105 ksi Minimum Tensile Strength.
 - h. A384/A384M, Standard Practice for Safeguarding Against
Warpage and Distortion During Hot-Dip Galvanizing of Steel
Assemblies.
 - i. A385/A385M, Standard Practice for Providing High-Quality Zinc
Coatings (Hot-Dip).

- j. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
 - k. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - l. A563, Standard Specification for Carbons and Alloy Steel Nuts.
 - m. A572/A572M, Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
 - n. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - o. A992/A992M, Standard Specification for Structural Steel Shapes.
 - p. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - q. A1085/A1085M, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
 - r. F436, Standard Specification for Hardened Steel Washers.
 - s. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
 - t. F1136, Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners.
 - u. F1852, Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - v. F2280, Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
 - w. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
- 5. Occupational Safety and Health Administration (OSHA).
 - 6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.

1.02 SUBMITTALS

A. Action Submittals:

- 1. Provide Shop Drawing details showing:
 - a. Erection plans.
 - b. Members, including piece numbers, sizes, grades, dimensions, cambers, and connection details.
 - c. Anchor bolt layouts.
 - d. Hardened washer details.
 - e. Connection material specifications.
 - f. Indicate type, size, and length of bolts.

- g. Joint details for complete penetration welds.
- h. Indicate welds by standard AWS symbols, distinguishing between shop and field welds and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

B. Informational Submittals:

- 1. Schedule for submittal of shop and erection drawings.
- 2. Name and address of manufacturer(s).
- 3. Mill certificates of tests made in accordance with ASTM A6/A6M.
- 4. Manufacturers' testing procedures and standards.
- 5. Preparation and installation or application instructions, as appropriate.
- 6. Proposed method to resolve misalignment between anchor bolts and bolt holes in steel members.
- 7. High-strength Bolts:
 - a. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that products meet specified chemical and mechanical requirements.
 - b. Manufacturer's inspection test report results for production lot(s) furnished to include:
 - 1) Tensile strength.
 - 2) Yield strength.
 - 3) Reduction of area.
 - 4) Elongation and hardness.
 - c. Certified Mill Test Reports for Bolts and Nuts:
 - 1) Name and address of manufacturer.
 - 2) Bolts correctly marked.
 - 3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.

1.03 QUALITY ASSURANCE

A. Certifications:

- 1. Mill identification marks, heat number, size of section, and length in accordance with ASTM A6/A6M.
- 2. AISC Quality Certification for Fabricator: A fabricator who participates in the AISC Certification program and is designated an AISC certified plant, Category STD.
- 3. AISC Quality Certification for Erector: An installer who participates in the AISC Certification program and is designated an AISC Certified Erector, Category CSE, or documented experience in erection of at least five similar structural steel facilities over past 10 years in lieu of AISC certification.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.
- B. Storage:
 - 1. Store materials to permit easy access for inspection and identification. Store in a dry area and keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - a. Do not store materials in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials as directed.
 - 2. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - a. Fasteners may be repackaged provided testing and inspecting agency observes repackaging and sealing of containers.
 - b. Clean and lubricate bolts and nuts that become dry or rusty before use.
 - c. Comply with manufacturer's written recommendations for cleaning and lubricating fasteners and for retesting fasteners after lubrication.
- C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Rolled Plates, Shapes except W-Shapes and Bars: ASTM A36/A36M, unless indicated otherwise.
- B. W-shapes: ASTM A992/A992M, unless indicated otherwise on Drawings.
- C. Steel Pipe: ASTM A53/A53M, Grade B, unless indicated otherwise on Drawings.
- D. Round Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C (Fy equals 46 ksi).
- E. Square and Rectangular Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C (Fy equals 50 ksi).

2.02 FASTENERS

- A. Anchor Bolts: As specified in Section 05 50 00, Metal Fabrications.
- B. Post-installed Anchors: As specified in Section 05 05 19, Post-Installed Anchors.
- C. High-strength Bolts:
 - 1. ASTM F593, AISI Type 316, Condition CW.
 - 2. Bolt Length and Thread Length: As required for connection type shown, with hardened washers as required.
- D. Nuts: ASTM A594, type to match bolt type and finish.
- E. Hardened Steel Flat and Beveled Washers: Type 316 stainless steel.

2.03 FABRICATION

- A. General:
 - 1. Fabricate as shown and in accordance with AISC 360 and AISC 303.
 - 2. Mark and match mark materials for field assembly.
 - 3. Complete assembly, including bolting and welding of units, before start of finishing operations.
 - 4. Fabricate to agree with field measurements.
 - 5. Fabricate beams with rolling camber up.
 - 6. Fillet re-entrant cuts and corners to radius of not less than 1/2 inch.
 - 7. Sheared and flame-cut edges shall be free from rough corners and projections.
- B. Connections:
 - 1. Shop Connections: Weld or bolt as shown on Drawings.
 - 2. Meet requirements of AISC 325 for bolted double-angle shear connections, unless indicated otherwise.
- C. Interface with Other Work:
 - 1. Holes:
 - a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members shall be approved by Engineer.
 - b. No flame-cut holes are permitted without prior approval of Engineer.
 - 2. Weld threaded nuts to framing members, and other specialty items to receive other Work.

PART 3 EXECUTION

3.01 ERECTION

A. General:

1. Meet requirements of AISC 360 and AISC 303, with exceptions as specified.
2. Install Contractor-designed temporary construction bracing to provide necessary support until components are in place and construction is complete.
3. Provide additional field connection material as required by AISC 303.
4. Splice members only where indicated and accepted on Shop Drawings.

B. Field Assembly:

1. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.
2. Set structural frames accurately to lines and elevations shown.
3. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.
4. Level and plumb individual members of structure within tolerances shown in AISC 303.
5. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.
6. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

C. Setting Baseplates and Bearing Plates:

1. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.
2. Clean bottom surface of baseplates and bearing plates.
3. Set loose and attached baseplates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling plates where indicated.
4. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washer to baseplate where indicated.
5. Grout Under Baseplate: As specified in Section 03 62 00, Grouting, prior to placing loads on structure.

D. Anchor Bolts:

1. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.
2. Provide templates and other devices for presetting bolts and other anchors to accurate locations.
3. Projection of anchor bolts beyond face of concrete and threaded length shall be adequate to allow for full engagement of threads of hold-down nuts, adjustment of leveling nuts, washer thicknesses, and construction tolerances, unless indicated otherwise.
4. Placement Tolerances:
 - a. As required by AISC 303, unless indicated otherwise.
 - b. Embedded anchor bolts shall not vary from dimensions shown on Drawings by more than the following:
 - 1) Center-to-center of Any Two Bolts Within an Anchor Group: 1/8 inch.
 - 2) Center-to-center of Adjacent Anchor Bolt Groups: 1/4 inch.
 - 3) Variation from Perpendicular to Theoretical Bearing Surface: 1:50.

E. Connections:

1. High-strength Bolted:
 - a. Tighten in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
 - b. Pretension all bolts unless noted otherwise on Drawings.
 - c. Hardened Washers:
 - 1) Provide at locations required by Washer Requirements section of RCSC Specification for Structural Joints Using High-Strength Bolts, to include pretensioned and slip critical connections using slotted or oversized holes or ASTM A490 bolts.
 - 2) Use beveled style and extra thickness where required by RCSC Specification.
 - 3) Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.
 - 4) Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.
 - d. For snug-tightened connections (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.

3.02 MISFITS

A. At Bolted Connections:

1. Immediately notify Engineer for approval of one of the following methods of correction:
 - a. Ream holes that must be enlarged to admit bolts and use oversized bolts.
 - b. Plug weld misaligned holes and redrill holes to admit standard size bolts.
 - c. Drill additional holes in connection, conforming to AISC for bolt spacing and end and edge distances, and add additional bolts.
 - d. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.
2. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

B. At Anchor Bolts:

1. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved Shop Drawing.
2. Do not flame cut to enlarge holes without prior approval of Engineer.

C. Gas Cutting:

1. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.
2. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Engineer.
3. Finish flame-cut sections equivalent to sheared and punched appearance.

3.03 REPAIR AND CLEANING

- A. Clean shop primer from field welds, bolted connections, and abraded areas immediately after erection.
- B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.
- C. Remove weld back-up bars and grind smooth where indicated on Drawings.
- D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-furnished Quality Control: Inspect and test as required in Section 01 45 16.13, Contractor Quality Control.
- B. Welding: Visually inspect field welds in accordance with AWS D1.6/D1.6M, Visual Inspection Acceptance Criteria.

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 Galvanizers Association (AGA):
 - a. Inspection of Hot-Dip Galvanized Steel Products.
 - b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
5. American National Standards Institute (ANSI).
6. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7. 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.
8. 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. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

- j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- k. A276, Standard Specification for Stainless Steel Bars and Shapes.
- l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
- o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
- p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
- q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
- r. A489, Standard Specification for Carbon Steel Lifting Eyes.
- s. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- t. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- u. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- v. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- w. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- x. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
- y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
- z. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
- aa. A992/A992M, Standard Specification for Structural Steel Shapes.
- bb. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
- cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- dd. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- ee. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- ff. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.

- gg. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- hh. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- ii. F436, Standard Specification for Hardened Steel Washers.
- jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
- kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- ll. F594, Standard Specification for Stainless Steel Nuts.
- mm. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- nn. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- 9. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
- 10. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910.27, Fixed Ladders.
 - b. 29 CFR 1926.105, Safety Nets.
 - c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
- 11. 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. 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.

- F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings: Metal fabrications, including welding and fastener information.
- 2. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals:

- 1. U-channel Concrete Inserts:
 - a. Manufacturer's product description.
 - b. Allowable load tables.
- 2. Pre-engineered Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.27 requirements.
- 3. Passivation method for stainless steel members.
- 4. Galvanized coating applicator qualifications.
- 5. Hot-dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

- 1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 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 and hot-dip galvanized finishes 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.

1.06 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following extra materials:

Item	Quantity
Neoprene gasket	Two for each location requiring neoprene gaskets
Neoprene Gasket Material: 4 inches wide by 50 feet long	One roll for each location requiring neoprene gaskets
Neoprene gasket adhesive	One (manufacturer's recommended) for each location requiring neoprene gaskets

- B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise indicated on Drawings, 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 6061-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

Item	ASTM Reference
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
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, hot-dip galvanized steel, zinc-plated 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 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 PIPE SLEEVES

- A. As specified in Section 40 27 01, Process Piping Specialties.
- B. ASTM A53/A53M, Schedule 40 steel pipe sleeves with continuously welded 3/16-inch-thick seep ring with outside diameter 3 inches greater than sleeve outside diameter. Hot-dip galvanize in accordance with ASTM A123/A123M.

2.05 STEEL LINTELS AND SHELF ANGLES

- A. ASTM A36/A36M, hot-dip galvanize after fabrication in accordance with ASTM A123/A123M.

2.06 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

- A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.
- B. Welded anchors for stainless steel support frames shall also be stainless steel.

2.07 LADDERS

- A. Fabricate ladders with rails, rungs, landings, and cages to meet applicable requirements of OSHA, CFR Part 1910.27, and ALI A14.3.
 - 1. Design ladder for concentrated load of 200 pounds imposed by user concentrated at points that will cause maximum stress in structural member being considered.
 - 2. Include weight of ladder and attached appurtenances together with live load in design of rails and fastenings.
 - 3. Self-closing gates at landings.
- B. Flat-bar Ladder:
 - 1. Punch rails, pass rungs through rails, and weld on outside.
 - 2. Weld brackets to ladder for fastening ladder to wall.
 - 3. ASTM A276, AISI Type 316L stainless steel.
- C. Ladder Safety Post:
 - 1. Telescoping tubular, spring balanced and automatically locking in raised position, with release lever for unlocking.
 - 2. Post: Stainless steel, AISI Type 304.
 - 3. Hardware: Stainless steel, AISI Type 316.

4. Furnish dissimilar metal protective coatings at connections.
5. Manufacturer and Product: Bilco Co., New Haven, CT; "Ladder Up" to fit ladder rungs.

2.08 SAFETY CLIMB DEVICE

A. General:

1. Conforms to ALI A14.3 and OSHA CFR Part 1910.27.
2. Belt and harness shall withstand minimum drop test of 250 pounds in 6-foot free fall.
3. Fall Prevention System Material: Stainless steel, AISI Type 316.

B. Components and Accessories:

1. Main Components: Sleeve or trolley, safety harness, and carrier or climbing rail.
2. Ladder rung clamps with stainless steel, AISI Type 316, mounting brackets and hardware.
3. Removable extension kit with tiedown rod or trolley gate, mandrel, and carrier rail for ladders under manholes and hatches.

C. Manufacturers and Products:

1. Miller by Honeywell, Franklin, PA; Miller Saf-T-Climb.
2. TS Products, Cambridge, Ontario, Canada; TS Safety Rail System.

2.09 LADDER CLIMB PREVENTION SHIELD

- A. Eight feet long with angled sides to within 2 inches of wall when closed.
- B. Furnish dissimilar metals protective coatings at bolted connections.
- C. Manufacturer and Product: North Safety Products, Specialty Products Division, Toronto, Ontario, Canada; Ladder Gate 770-000-001.

2.10 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 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.

2.11 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. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.
3. 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.

D. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanize steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

E. Electrolytic Protection: Coat surfaces of galvanized steel and 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 of a type that is satisfactory for use in potable water distribution facilities. 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.

2.12 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 water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

D. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on Drawings.

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 on Drawings.

3.03 U-CHANNEL CONCRETE INSERTS

- A. Provide as indicated for pipe supports and where otherwise shown on Drawings.
- B. Except for interior dry areas, use plastic clips or similar dielectric material to isolate channel anchors from concrete reinforcing steel.

3.04 SAFETY CLIMB DEVICE SYSTEM

- A. Provide for each ladder where unbroken height between levels exceeds 20 feet, or at lesser height where indicated on Drawings.
- B. Install in accordance with manufacturer's instructions.
- C. Furnish additional accessories required to complete system for each ladder.
- D. Furnish one harness for each ladder equipped with safety climb device.
- E. Furnish pivot section at platforms, landings, and roofs.
- F. When installed to required height, fall prevention system shall be rigid and an integral part of the structure.

3.05 ELECTROLYTIC PROTECTION

- A. Aluminum and Galvanized Steel:
 - 1. Coat surfaces of galvanized steel and 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. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
 - 3. Allow coating to dry before installation of the material.
 - 4. Protect coated surfaces during installation.
 - 5. 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.

3.06 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.
2. Manufacturer's Certificate of Compliance in accordance with 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.

3.07 FASTENER SCHEDULE

- A. Provide fasteners as shown on Drawings.
- B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 05 52 13
PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes: Stainless steel railings.

1.03 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project Site in time for installation.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data:
 - a. Manufacturer's product lines of mechanically connected railings.
 - b. Fasteners.
 - c. Post-installed anchors.
 - d. Handrail brackets.
 - e. Nonshrink, nonmetallic grout.
 - f. Anchoring cement.
 - g. Metal finishes.
 - 2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 3. Samples for Initial Selection: For products involving selection of color, texture, or design.

4. Samples for Verification: For each type of exposed finish required.
 - a. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
 - b. Fittings and brackets.
 - c. Assembled sample of railing system, made from full-size components, including top rail post, handrail, and infill. Sample need not be full height.
 - 1) Show method of connecting members at intersections.
5. Delegated-design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Informational Submittals:

1. Qualification Data: For delegated-design professional engineer.
2. Welding certificates.
3. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.
4. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
5. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
6. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following.
1. AWS D1.1/D1.1M, Structural Welding Code – Steel.
 2. AWS D1.6/D1.6M, Structural Welding Code – Stainless steel.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated-design: Engage a qualified professional engineer, to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 foot-pounds per foot applied in any direction.
 - b. Concentrated load of 200 pounds per foot applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 pounds per foot applied horizontally on an area of 1 square foot.
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.02 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.03 STAINLESS STEEL RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Tubing: ASTM A554, Grade MT 316L.
- C. Pipe: ASTM A312/A312M, Grade TP 316L.

- D. Castings: ASTM A743/A743M, Grade CF 8M or CF 3M.
- E. Plate and Sheet: ASTM A240/A240M or ASTM A666, Type 316L.

2.04 FASTENERS

- A. Fastener Materials:
 - 1. Stainless Steel Railing Components: Type 316 stainless steel fasteners.
 - 2. Finish exposed fasteners to match appearance, including color and texture, of railings.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 3. Provide Phillips, tamper-resistant or square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193.
 - 1. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.05 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
 - 1. For stainless steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

2.06 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 - 1. Provide weep holes where water may accumulate.
 - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded or nonwelded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.

- J. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
- O. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.07 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces.
 - 3. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Stainless Steel Pipe and Tubing Finishes:
 - 1. 180-grit Polished Finish: Uniform, directionally textured finish.
 - 2. 320-grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
 - 3. Polished and Buffed Finish: 320-grit finish followed by buffing to a high luster finish.

D. Stainless Steel Sheet and Plate Finishes:

1. Directional Satin Finish: ASTM A480/A480, No. 4.
2. High-luster Finish: ASTM A480/A480M, No. 7.
3. Mirror Finish: ASTM A480/A480M, No. 8.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
1. Fit exposed connections together to form tight, hairline joints.
 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.03 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Article, Fabrication whether welding is performed in the shop or in the field.

3.04 ANCHORING POSTS

- A. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.
 - 2. For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.
 - 3. For stainless steel railings, weld flanges to post and bolt to supporting surfaces.

3.05 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with flanges connected to railing ends and anchored to wall construction with anchors and bolts.
- B. Attach handrails to walls with wall brackets, except where end flanges are used.
 - 1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- C. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

3.06 CLEANING

- A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.07 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 05 53 00 METAL GRATINGS

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): Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - d. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. MBG 531, Metal Bar Grating Manual.
 - b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
 - b. Grating Anchorage: Show details of anchorage to supports to prevent displacement from traffic impact.
 - c. Product data for grating, grating clips, anchors, accessories, and other manufactured products specified herein.
 - d. Manufacturer's specifications, including coatings, surface treatment, and finishes.
2. Samples: Two samples of grating approximately 4 inches by 8 inches, showing at least four crossbars each and four bearing bars each. One Sample will be retained at Site to be used as a basis for acceptance or rejection of grating installed.

B. Informational Submittals:

1. Special handling and storage requirements.
2. Installation instructions.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Insofar as is practical, factory assemble items.
- B. Package and clearly tag parts and assemblies that are, due to necessity, shipped unassembled.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. Alabama Metal Industries Corporation (AMICO), Birmingham, AL.
 2. HARSCO Industrial IKG, Houston, TX.
 3. Ohio Gratings, Inc., Canton, OH.

2.02 GRATING MATERIALS

- A. Stainless Steel:
1. Bearing Bars, Banding, and Cross Bars: ASTM A666, Type 316L.
 2. Finish: Mill.

2.03 METAL BAR GRATING

- A. General Requirements:
1. Maximum Service Load:
 - a. Light-duty (Type A): 100 psf uniformly distributed load.
 2. Maximum Deflection: Span/240 or 1/4 inch, whichever is less.
 3. Bearing Bar Spacing:
 - a. Light-duty: 1-3/16 inch maximum, center-to-center.
 4. Cross Bar Spacing: 4 inches maximum, center-to-center.
 5. Bearing Bars, Cross Bars, and Banding: Minimum thickness as specified in NAAMM MBG 531 or as shown on Drawings.
- B. Grating Materials: Stainless steel welded, rectangular bar grating fabricated by welding cross bars to bearing bars.

C. Surface:

1. Serrated.
2. When surface of bars is serrated provide 1/4-inch deeper bearing bars than shown on Drawings to maintain specified load carrying capacity of grating.

2.04 ACCESSORIES

A. Embedded Frames: As indicated on Drawings and as specified in Section 05 50 00, Metal Fabrications.

B. Grating Clamps:

1. Use at flanged beam and bolted angle frame supports.
2. Removable from above grating walkway surface.
3. Provide hat bracket, recessed bolt, and bottom clamp of same material as grating.
4. Manufacturers and Products:
 - a. Direct Metals Company, LLC, Kennesaw, GA; Grating Clamp.
 - b. Grating Fasteners, Inc., Harvey, LA; G-Clip.

C. Anchor Stud and Saddle Clip:

1. Use at embedded angle frame supports with stud anchor and nut recessed below top of grating surface.
2. Removable from above grating walkway surface.
3. Provide Type 316 stainless steel welded threaded stud anchor, nut, washer, and saddle clip.
4. Manufacturers and Products:
 - a. Welded Stud Anchor:
 - 1) Nelson Stud Welding, Inc., Elyria, OH.
 - 2) Stud Welding Associates, Inc. Elyria, OH.
 - b. Saddle Clip:
 - 1) Direct Metals Company, LLC, Kennesaw, GA; Saddle Clip.
 - 2) Grating Fasteners, Inc., Harvey, LA; Saddle Clip.
 - 3) Struct-Fast, Inc., Baltimore, MD; Gratefast.

2.05 FABRICATION

A. General:

1. In accordance with NAAMM MBG 531 or NAAMM MBG 532.
2. Do not weld aluminum grating.
3. Conceal fastenings where practical.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.

5. Cutouts:
 - a. Fabricate in grating sections for penetrations indicated.
 - b. Arrange to permit grating removal without disturbing items penetrating grating.
 - c. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
 6. Do not notch bearing bars at supports to maintain elevation.
 7. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
 8. Section Length: Sufficient to prevent section from falling through clear opening when oriented in the span direction and one end is touching either the concrete or the vertical leg of grating support.
 9. Minimum Bearing: 1 inch for grating depth up to 2-1/4 inches and 2 inches for grating depth greater than 2-1/4 inches.
 10. Banding and Toe Plates: Same material as grating and welded to bearing bars in accordance with requirements of NAAMM MBG 531 and NAAMM MBG 532.
- B. Metal Bar Grating: A single grating section shall be not less than 1.5 feet or greater than 3 feet in width, or weigh more than 150 pounds.
- C. Heavy-duty Metal Bar Grating: Minimum width of grating sections shall be 2 feet regardless of length and weight.
- D. Supports:
1. Same material as grating, except that supports which are to be embedded in concrete shall be Type 316 stainless steel, unless part of an extruded aluminum system.
 2. Coordinate dimensions and fabrication with grating to be supported.
 3. Coordinate dimensions with increased depth due to serrations.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Until grating sections are securely fastened in place, area shall be appropriately barricaded or flagged to alert people working in the area of potential fall hazard.
- B. Install manufactured products in accordance with manufacturer's recommendations.
- C. Install supports such that grating sections have a solid bearing on both ends, and that grating sections will not rock or wobble under design loads.

- D. Install grating supports plumb and level as applicable.
- E. Install sections of welded frames with anchors to straight plane without offsets.
- F. Field locate and install fasteners to fit grating layout.
- G. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.
- H. Each grating or plank section shall be easily removable and replaceable.
- I. Completed installation shall be rigid and neat in appearance.
- J. Protect painted and galvanized surfaces during installation.

END OF SECTION

SECTION 07 16 00
CEMENTITIOUS WATERPROOFING

PART 1 GENERAL

1.01 SUBMITTALS

- A. Action Submittals: Manufacturer's product data.
- B. Informational Submittals: Manufacturer's application instructions.

1.02 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in area where temperature is not less than 50 degrees F or over 85 degrees F, unless otherwise authorized in writing by manufacturer.

PART 2 PRODUCTS

2.01 WATERPROOFING

- A. Type: Cement-base, with aggregate.
- B. Manufacturers and Products:
 - 1. Xypex Chemical Corporation, Richmond, B.C., Canada; Xypex Concentrate.
 - 2. "Or-equal."

PART 3 EXECUTION

3.01 SURFACE PREPARATION

- A. Clean surfaces to remove dust, dirt, oil, wax, efflorescence, and other foreign materials, in accordance with waterproofing manufacturer's instructions.
- B. Do not use foam treatments that might stain or otherwise injure concrete or prevent a good bond.
- C. Cut tie rods or steel separators back to depth of 1 inch and patch holes, cracks, spalled concrete, and honeycombed areas as recommended by waterproofing manufacturer.

3.02 APPLICATION

- A. Dampen surface immediately ahead of application with clean water.
- B. Brush apply a minimum of two coats; mixture and quantities as recommended by manufacturer.
- C. Do not apply waterproofing as a thin paint coat. Lay it on the surface and level it out so as to fill and seal pores and voids.
- D. Do not proceed with application of materials when ambient temperature is less than 50 degrees F.

3.03 FIELD QUALITY CONTROL

- A. After waterproofing has dried, spray coated surfaces with water. Recoat surfaces that show water absorption.

3.04 APPLICATION SCHEDULE

- A. Apply waterproofing materials to exterior surfaces of cast-in-place concrete structures below finish ground level that enclose spaces that may be occupied, such as stairways, galleries, pump rooms, mechanical and electrical equipment rooms, and other areas shown, but not including water-holding basins. Apply coating from top of footings to 6 inches below finished grade.

END OF SECTION

**SECTION 08 30 00
SPECIALTY DOORS**

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, Incorporated (AA): Designation System for Aluminum Finishes.
2. American Iron and Steel Institute (AISI).
3. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix VIII.
4. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - c. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - d. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - e. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - f. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - g. C1363, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
5. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code.
7. UL: Building Materials Directory.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Shop Drawings showing construction and installation details, and electrical characteristics and control diagrams for motor operators.
 - b. Identify each door with same reference as used on Drawings.

2. Samples: Manufacturer's current color sample(s) for factory finished coatings.

B. Informational Submittals:

1. Watertight Door: Furnish manufacturer's certification of leak tightness based on actual tests conducted on this door, or a door similar in design, to verify it will withstand specified hydrostatic pressure with no evident leakage.

1.03 QUALITY ASSURANCE

- A. Qualifications:** Experienced, factory authorized installer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A.** Deliver doors with separators and wrapping to protect units from damage during and after installation.
- B.** Store doors in protected dry area following manufacturer's requirements.
- C.** Handle doors according to manufacturer's instructions.
- D.** Protect exposed finish surfaces of prefabricated items with wrapping.

PART 2 PRODUCTS

2.01 WATERTIGHT DOORS

A. Manufacturers:

1. Freeman Marine; Gold Beach, OR.
2. Overly Manufacturing Co., Greensburg, PA.
3. Presray Corp., Pawling, NY.

- B. Manufactured Unit:** Door and frame assemblies designed for no visible leakage under design hydrostatic pressure.

C. Design Requirements:

1. Complete assembly, each component and anchorage to building to be designed to withstand hydrostatic pressure of 32 feet of water above sill.
2. Safety Factor: 2; based on yield.

D. Materials:

1. Structural Plates and Shapes: ASTM A167, Type 316 stainless steel.
2. Gaskets: Molded neoprene with fully molded corners.

- E. Frame and Subframe: Continuously welded stainless steel with anchors for embedment in concrete.
- F. Door: 5/8-inch minimum thick stainless steel.
- G. Hardware:
 - 1. Hinges: Upper radial, lower thrust, with stainless steel pins and slotted blade to prevent hinges from carrying hydrostatic load.
 - 2. Latching: Minimum of six dogs activated by handwheels from either side of door.
- H. Accessories: Provide manufacturer's standard laminated glass sight glass near bottom of door.
- I. Finishes:
 - 1. Steel: Clean surfaces and apply one coat of corrosion-inhibiting primer coating compatible with finish coating as specified in Section 09 90 00, Painting and Coating.
 - 2. Stainless Steel: ASTM A480/A480M, No. 2B.
- J. Test and Inspections:
 - 1. Test welds in leak path in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix VIII.
 - 2. Certify watertightness of assembly under hydrostatic pressure specified. Basis of certification shall be full-scale factory tests of assembly, or assembly of similar design.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install special doors in accordance with the manufacturer's recommendations and printed instructions.
- B. Adjust doors for smooth, satisfactory operation.

3.02 PRIME COAT TOUCHUP

- A. Damaged Prime Coat:
 - 1. Remove rust.
 - 2. Sand smooth.
 - 3. Use same primer as shop.
 - 4. Touch up so it is not obvious.

3.03 PROTECTION

- A. Protect installed doors against damage from other construction work.

3.04 SCHEDULE

- A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see Drawings.

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 Administration (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.
 - l. SP 13, Surface Preparation of Concrete.
 - m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

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.
 - c. Certification for compliance to NSF/ANSI 61 where required.
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.
- 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.

C. Work Plan: Submit complete and detailed work plan(s) at least 30 days prior to beginning surface preparation or painting operations in a new work area, or on new surfaces or substrates. Include:

- 1. Scaffolding plans and calculations signed and sealed by a professional engineer in the State of New Jersey.
- 2. Anticipated surface preparation requirements, methods, tools, and equipment.

3. Paint application methods.
4. Location-specific protection methods for existing surfaces and equipment including:
 - a. Containment plans to prevent stripped paint, dust, debris, etc. from entering wastewater process trains or plant drains.
 - b. Plans to contain all wash water generated from pressure washer cleaning activities.
 - c. Details on protection of existing equipment including but not limited to motors, compressors, plant instruments, valves, and control panels.
5. Lighting, heating, ventilating, and humidity control requirements, procedures, and equipment.
6. Warning sign positions.
7. Anticipated outages of existing plant equipment or systems.
8. Anticipated daily work schedule.
9. Anticipated duration of all painting work included in this work plan.
10. Clean-up and housekeeping activities.
11. Plans for disposal of all generated waste.

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.
- 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 top-coated, 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.

B. Status of Existing Coatings: The following information on existing coatings or substrate conditions is provided for information only, and is generally believed to be accurate, but is not guaranteed. Perform tests as required to verify applicability of this information to the Work.

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.

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
Alkyd (semigloss)	Semigloss alkyd
Alkyd enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
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
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
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/ANSI 61, where required
Epoxy nonskid (aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately

Product	Definition
Fusion-bonded coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Fusion-bonded, TFE lube or grease lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation., Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA
High-build epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
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/ANSI 61
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
Rust-inhibitive primer	Single-package steel primers with anticorrosive pigment loading
Sanding sealer	Co-polymer oil, clear, dull luster
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 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.
 - e. For conventional (alkyd) coatings, clean asphalt varnish supplied on pipe and apply one full coat of a tar stop before two full coats of the color coats specified.
 - 2. Steel Pipe:
 - a. Surface preparation and application of primer 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.
- D. Do not paint stainless steel, copper, or galvanized steel unless specifically noted on the Drawings.

3.02 EXAMINATION

- A. Factory-finished Items:
 - 1. Schedule inspection with Engineer before repairing damaged factory-finished 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. 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.
- C. 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.
- D. 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.

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. 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 new, interior 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. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion-bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. 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.
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.
- B. Additional requirements are included in the Piping Schedule.
- C. 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.

D. System No. 4 Exposed Metal:

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.

E. System No. 7 Concrete-encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	High-build epoxy	2 coats, 8 MDFT

1. Use on the following items or areas:
 - a. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles.

3.08 COLORS

- A. Provide as selected by Owner.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

3.09 ACCEPTED PRODUCTS

1. Epoxy Primer-ferrous Metal:
Sherwin Williams: Macropoxy 646 Fast Cure Epoxy or PW Version
Tnemec: N140 Potapox Plus
Carboline: Carboguard 60
2. Polyurethane Enamel:
Sherwin Williams: Acrolon 218 High Solids Polyurethane B65-600
Tnemec: Series V73 Endurashield with #56 Thinner
Carboline: Carbothane 134 HG
3. High-build Epoxy:
Sherwin Williams: Macropoxy 646 PW Epoxy B58 WXZ Series
Tnemec: N69, HB Epoxoline II
Carboline: Carboguard 60

4. NSF Epoxy: Sherwin Williams: Macropoxy 646 PW
Tnemec: N140 Potapox Plus
Carboline: Carboguard 61

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. Product Data Sheet (PDS).

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete this PSDS for each 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 Spec.):		
Paint System Title (from Spec.):		
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 PDS for each 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			
Minimum Recoat Time			
Maximum 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 10 14 00

SIGNAGE

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): A13.1, Scheme for the Identification of Piping Systems.
 2. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - b. D709, Standard Specification for Laminated Thermosetting Materials.
 3. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
 4. International Code Council (ICC):
 - a. A117.1, Accessible and Usable Buildings and Facilities.
 - b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
 5. National Fire Protection Association (NFPA):
 - a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
 - b. HAZ-01, Fire Protection Guide to Hazardous Materials.
 6. Occupational Safety and Health Administration (OSHA).
 7. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices for Streets and Highways.

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
 - a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
 - b. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.
 2. Samples: One full size for each type of nameplate, sign, and label specified.
- B. Informational Submittals: Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 IDENTIFICATION LABELS

A. Pipe Labels:

1. Labels: Self-adhesive tape, with separate directional flow arrows.
2. Material: Pressure-sensitive vinyl.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: ASME A13.1.
5. Message: Piping system name as indicated on Piping Schedule.
6. Manufacturers and Products:
 - a. Brady Signmark; B-946 Self-Sticking Vinyl Pipe Markers and Vinyl Arrows.
 - b. Seton Identification Products; Opti-Code Markers and Directional Arrows.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: White engraved, 3/4 inch minimum high.
3. Background: Black.
4. Materials: Multi-layered acrylic.
5. Furnish 1-inch margin with holes at each end of label, for mounting. On fiberglass labels, furnish grommets at each hole.
6. Size:
 - a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
 - b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
 - a. Brady Signmark.
 - b. Seton Identification Products.

2.02 ANCILLARY MATERIALS

- A. Fasteners: Stainless steel screws or bolts of appropriate sizes.
- B. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.
- C. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.
- D. Manufacturer's standard brackets for wall mounting of two-sided exit signs.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

- A. In accordance with manufacturer's recommendations.
- B. Mount securely, plumb, and level.

3.02 IDENTIFICATION LABELS

- A. Pipe Labels:
 - 1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
 - 2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
 - 3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
 - 4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
 - 5. Apply to pipe after painting in vicinity is complete, or as approved by Engineer.
 - 6. Install in accordance with manufacturer's instructions.
- B. Equipment Labels:
 - 1. Locate and install on equipment or concrete equipment base.
 - 2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

END OF SECTION

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

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Shielded variable frequency drive (VFD) power cable.

1.03 DEFINITIONS

- A. VFD: Variable frequency drive.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.
- B. Informational Submittals: Field quality control reports.

PART 2 PRODUCTS

2.01 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following.
 - 1. Alpha Wire.
 - 2. Belden Inc.
 - 3. Encore Wire Corporation.
 - 4. General Cable Technologies Corporation.
 - 5. Southwire Incorporated.
- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type XHHW-2.
- D. VFD Cable:
 - 1. Cable to be listed UL 44, UL 1277 for Type TC-ER; 600V/1000V (minimum) rated, with stranded tinned copper conductors according to ASTM B3, B8 and B33, shielded, suitable for use with VFDs. XLPE (XHHW-2 listed) insulation with ICEA Method 4 color-coding and shall be rated for 90 degrees C wet/dry operating temperature.
 - 2. Insulated conductors are to be cabled together with a minimum of one ground wire. Ground wire(s) are to have a minimum circular mil area equivalent to one circuit conductor. Fillers shall be included as necessary to make the cable round.
 - 3. Cabled assembly shall be shielded using one of two methods:
 - a. Applying helically two 2-mil copper tapes. Shield shall provide 100 percent coverage over the assembly;
 - OR
 - b. Applying 80 percent minimum coverage tinned copper braid shield used in conjunction with an aluminum foil shield tape.
 - 4. All cables shall have a continuous overall outer sheath of polyvinyl chloride (PVC), suitable for 90 degrees C use.
 - 5. Accessories (terminations) shall have ratings that are at least equal to those of the cable.
 - 6. Manufacturers and Products:
 - a. Belden; #29500 Series.
 - b. AmerCable.
 - c. Southwire.

2.02 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following.
 - 1. AFC Cable Systems, Inc.
 - 2. Gardner Bender.
 - 3. Hubbell Power Systems, Inc.
 - 4. Ideal Industries, Inc.
 - 5. IlSCO, a branch of Bardes Corporation.
 - 6. NSi Industries LLC.
 - 7. O-Z/Gedney, a brand of EGS Electrical Group.
 - 8. 3M, Electrical Markets Division.
 - 9. Tyco Electronics.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.03 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Stranded for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type XHHW-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type XHHW, XHHW-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type XHHW, XHHW2, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW, XHHW-2, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-grade, and Underground: Type XHHW-2, single conductors in raceway.
- H. VFD Output Circuits: Shielded VFD power cable as specified above.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33, Raceways and Boxes for Electrical Systems prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29, Hangers and Supports for Electrical Systems.

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.05 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53, Identification for Electrical Systems.
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44, Sleeves and Sleeve Seals for Electrical Raceways and Cabling.

3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.08 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Test and Inspection Reports: Prepare a written report to record the following.
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications: Ground bonding common with lightning protection system.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product indicated.
- B. Informational Submittals:
 - 1. Plans showing dimensioned as-built locations of grounding features specified in Article, Field Quality Control including the following:
 - a. Test wells.
 - b. Ground rods.
 - c. Ground rings.
 - d. Grounding arrangements and connections for separately derived systems.
 - 2. Field quality-control reports.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, Operation and Maintenance Data, include the following:
 - a. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar.
- D. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 inch by 4 inches (6.3 mm by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5,000 V.

2.02 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Hydraulic Compression Type Connectors for Conductors: Copper or copper alloy.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.03 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Or as otherwise indicated on the Drawings.

PART 3 EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install stranded conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Grounding Bus: Install in electrical in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 24 inches (150 mm) above finished floor unless otherwise indicated.

D. Conductor Terminations and Connections:

1. Equipment Grounding Conductor Terminations: Compression type.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Exothermic welded unless specifically detailed otherwise.
4. Connections to Structural Steel: Welded connectors.

3.02 EQUIPMENT GROUNDING

- A. Install green insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install green insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Shielded VFD cable installations.
- C. Air-duct Equipment Circuits: Install green insulated equipment grounding conductor to duct-mounted electrical devices, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-tracing, and Antifrost Heating Cables: Install a green separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.03 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 26 05 43, Underground Ducts and Raceways for Electrical Systems, and shall be at least 12 inches (300 mm) deep, with cover.
 - 1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

- F. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.
 - 1. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.

3.04 LABELING

- A. Comply with requirements in Section 26 05 53, Identification for Electrical Systems for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer.
 - 1. Label Text: If this connector or cable is loose or if it must be removed for any reason, notify the facility manager.

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

- E. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.03 DEFINITIONS

- A. RMC: Rigid metal conduit. Also referred to as rigid galvanized steel (RGS) on Contract Drawings.

1.04 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data:
 - a. Steel slotted support systems.
 - b. Nonmetallic slotted support systems.
 - 2. Shop Drawings: Show fabrication and installation details for the following.
 - a. Trapeze Hangers. Include product data for components.
 - b. Hot-dipped galvanized steel slotted channel systems. Include product data for components.

- c. Nonmetallic slotted channel systems. Include product data for components.
- d. Equipment supports.

1.06 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
- B. Comply with NFPA 70.

1.07 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

PART 2 PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Hot-dipped Galvanized Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
 - 2. Channel Dimensions: Selected for applicable load criteria.
 - 3. Fitting and Accessory Materials: Type 316 stainless steel in non-corrosive or chemical areas. Threaded rod shall be galvanized steel.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels, threaded rods, and angles.
 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Hot-dipped galvanized steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be RGS.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following.
1. Mechanical-expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1) Cooper B-Line, Inc.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 2. Concrete Inserts: Type 316 stainless steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 4. Through-bolts: Structural type, hex head, and high-strength. Comply with ASTM A 325.
 5. Toggle Bolts: All-steel springhead type.
 6. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 pounds (90 kg).
- D. Mounting and Anchorage of Surface-mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through-bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Light Steel: Sheet metal screws.
 5. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup, Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Handholes and boxes for exterior underground cabling.
- B. Related Requirements: Section 26 05 43, Underground Ducts and Raceways for Electrical Systems for exterior duct banks, manholes, and underground utility construction.

1.03 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit. Also referred to as rigid galvanized steel (RGS) on Contract Drawings.
- C. LFMC: Liquid-tight flexible metal conduit.
- D. LFNC: Liquid-tight flexible nonmetallic conduit.
- E. PVC-coated: Polyvinyl chloride (PVC) coated rigid steel conduit.
- F. RTRC: Reinforced thermosetting resin rigid conduit. Also referred to as fiberglass-reinforced epoxy conduit (FRE) on Contract Drawings.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For wireways and fittings, hinged-cover enclosures, and cabinets.

2. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 PRODUCTS

2.01 CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following.
 1. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit.
 3. Anamet Electrical, Inc.
 4. Champion.
 5. Electri-Flex Company.
 6. FRE Northeast.
 7. Thomas and Betts, Ocal.
 8. O-Z/Gedney.
 9. Picoma Industries.
 10. Republic Conduit.
 11. Robroy Industries.
 12. Southwire Company.
 13. Thomas & Betts Corporation.
 14. Western Tube and Conduit Corporation.
 15. Wheatland Tube Company.
- B. Listing and Labeling: Conduits and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Galvanized Rigid Steel Conduit (GRC): Comply with ANSI C80.1 and UL 6.
- D. Liquid-tight Flexible Metal Conduit (LFMC): Flexible steel conduit with polyvinyl chloride (PVC) jacket and complying with UL 360. For use in damp locations as noted on the plans. Maximum length to not exceed 36 inches.
- E. PVC-coated Steel Conduit: PVC-coated RGS conduit.
 1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. Reinforced Thermosetting Resin Rigid Conduit (RTRC) (a.k.a., Rigid Non-metallic Fiberglass Conduits and Fittings, FRE – Fiberglass-reinforced Epoxy Conduit):
 1. Conduits and fittings shall consist of continuous E or E-CR glass roving encapsulated in an internally steam-cured, corrosion-resistant epoxy

resin system pigmented with ultraviolet (UV)-inhibiting carbon black dispersed homogeneously manufactured for use at temperatures ranging from minus 40 degrees F (minus 40 degrees C) to 230 degrees F (110 degrees C). Resin system substitution shall not be permitted. Epoxy resin system shall be impervious to a wide spectrum of chemicals and shall contain by weight less than 0.2 percent halogens as chlorine and shall not contain other toxic materials in excess of trace levels limits compliant with OSHA requirements. Conduits and fittings shall be listed as suitable for installation in locations shown on Drawings.

2. Conduits and fittings shall be free from defects and commercially practicable in color, opacity, density and other physical properties. The exterior surface finish shall be smooth in accordance with acceptable industry practices. Conduits and fittings shall be marked at least once with a suitable identifying mark printed on the outside of the product. Such marking shall contain:
 - a. RTRC.
 - b. For use minus 40 degrees C to 110 degrees C (minus 40 degrees F to 230 degrees F) or other applicable temperature.
 - c. Trade size.
 - d. Manufacturer's name or trademark.
 - e. AG.
 - f. Part number.
 - g. Degrees and radii (elbows only).
 - h. Date of manufacture.
3. Conduits and fittings shall be free from defects and commercially practicable in color, opacity, density and other physical properties. The exterior surface finish shall be smooth in accordance with acceptable industry practices.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Expansion Fittings: GRC to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
2. Use threaded fittings and couplings for all GRC connections. Compression-type fittings not permitted.

H. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following.
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Mono-Systems, Inc.
 - 4. Square D.
- B. Description: Hot-dipped galvanized sheet metal, complying with UL 870 and NEMA 250, Type 12 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Galvanized.

2.03 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following.
 - 1. Adalet.
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman.
 - 7. Hubbell Incorporated.
 - 8. Kraloy.
 - 9. Milbank Manufacturing Co.
 - 10. Mono-Systems, Inc.
 - 11. O-Z/Gedney.
 - 12. RACO; Hubbell.
 - 13. Robroy Industries.
 - 14. Spring City Electrical Manufacturing Company.
 - 15. Stahlin Non-Metallic Enclosures.
 - 16. Thomas & Betts Corporation, Ocal.
 - 17. Wiremold / Legrand.

- B. Cast-metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- C. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 pounds (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 pounds (23 kg) shall be listed and marked for the maximum allowable weight. Pendant mounted luminaires shall use ball/socket swivel support hangers as required.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1. Used in recessed applications.
- E. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).
- F. Gangable boxes are prohibited.
- G. Boxes shall be polycarbonate for submersible locations and galvanized steel for exposed locations.
- H. Cabinets:
 - 1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated.
 - 1. Exposed Conduit: PVC-coated.
 - 2. Connection to Vibrating Equipment (Including Transformers or Motor-Driven Equipment): LFMC.
 - 3. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
 - 1. Exposed, Not Subject to Severe Physical Damage: GRC or RTRC or PVC-coated where noted on Drawings.

2. Exposed and Subject to Severe Physical Damage: GRC or PVC-coated where noted on Drawings. Raceway locations include the following:
 - a. Mechanical rooms.
 - b. Pump room around pumps.
 3. Concealed in Ceilings and Interior Walls and Partitions: GRC.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-driven Equipment): use LFMC.
 5. Damp or Wet Locations: PVC-coated.
- C. Corrosive Areas:
1. PVC-coated RGS.
 2. RTRC, FRE.
- D. Hazardous Gas Areas: RGS.
- E. Concrete-encased Duct Bank:
1. RTRC, FRE.
 2. PVC-coated where noted on Drawings.
- F. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- G. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. GRC: Use threaded galvanized rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. Flexible Conduit: Use only metallic fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- H. Do not install aluminum conduits, boxes, or fittings.

3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 26 05 29, Hangers and Supports for Electrical Systems for hangers and supports.

- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- G. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
 - 5. Change from RTRC/FRE to PVC-coated or GRC before rising above floor.
- H. Stub-ups to Above Recessed Ceilings:
 - 1. Use RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- I. Coat field-cut threads on all metallic and PVC-coated raceways with a corrosion-preventing conductive compound prior to assembly.
- J. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- K. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path. Apply touch-up painting with matching manufacturers paint to protect protective coating and finish.
- L. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-pound (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

- N. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- O. Expansion-Joint Fittings:
1. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 degrees F (55 degrees C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degrees F (70 degrees C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 degrees F (86 degrees C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 degrees F (70 degrees C) temperature change.
 - d. Attics: 135 degrees F (75 degrees C) temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per degree F (0.0115 mm per meter of length of straight run per degree C) of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- P. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1,830 mm) of flexible conduit for recessed and semirecessed luminaires, use a maximum of 24 inches of LFMC for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC for all equipment and luminaires installed in damp or wet locations subject to severe physical damage.
- Q. Mount outlet boxes at 18 inches above finished floor (AFF) and switch boxes at 48 inches AFF. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
- R. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

- S. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- T. Locate boxes so that cover or plate will not span different building finishes.
- U. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- V. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.03 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks, and in single duct runs. See Specifications Section 26 05 33, Raceways and Boxes for Electrical Systems, Article Conduits and Fittings, paragraph Reinforced Thermosetting Resin Rigid Conduit (RTRC).
 - 2. Handholes and boxes.

1.03 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. RNC: Rigid nonmetallic conduit. See Specifications Section 26 05 33, Raceways and Boxes for Electrical Systems, Article Conduits and Fittings, paragraph Reinforced Thermosetting Resin Rigid Conduit (RTRC).

1.04 SUBMITTALS

- A. Action Submittals: Product data for the following.
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, bends, fittings, and solvent cement.
 - 3. Accessories for handholes, boxes, and other utility structures.
 - 4. Warning tape.
- B. Shop Drawings for Factory-fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following,
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.

C. Informational Submittals:

1. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
2. Qualification Data: For professional engineer and testing agency.
3. Source quality-control test reports.
4. Field quality-control test reports.

1.05 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project Site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project Site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

1.07 COORDINATION

- A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into handholes and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Engineer.

PART 2 PRODUCTS

2.01 CONDUIT

- A. Galvanized Rigid Steel Conduit (GRC): Comply with ANSI C80.1.
- B. RNC: See Specifications Section 26 05 33, Raceways and Boxes for Electrical Systems, Article Conduits and Fittings, paragraph Reinforced Thermosetting Resin Rigid Conduit (RTRC).

- C. PVC-coated Rigid Galvanized Steel Conduit: See Specifications Section 26 05 33, Raceways and Boxes for Electrical Systems, Article Conduits and Fittings, paragraph PVC-coated Steel Conduit.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. Certain Teed Corp., Pipe and Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. IPEX Inc.
 - 8. Lamson & Sessions; Carlon Electrical Products.
 - 9. Manhattan/CDT; a division of Cable Design Technologies.
 - 10. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line traceable/identifiable warning tape specified in Section 26 05 53, Identification for Electrical Systems.

2.03 CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following.
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. Anamet Electrical, Inc.
 - 4. Champion.
 - 5. Electri-Flex Company.
 - 6. FRE Northeast.
 - 7. Thomas & Betts, Ocal.
 - 8. O-Z/Gedney.
 - 9. Picoma Industries.
 - 10. Republic Conduit.
 - 11. Robroy Industries.
 - 12. Southwire Company.
 - 13. Thomas & Betts Corporation.

14. Western Tube and Conduit Corporation.
 15. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
1. Color: Gray.
 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
 - e. Quazite – A Hubble Corporation.
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.

2.05 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77.

PART 3 EXECUTION

3.01 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 V and Less and Smaller than 2-inch Diameter: RNC, NEMA Type EPC-80-PVC for horizontal runs and horizontal sweeps in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and 2-inch Diameter and Greater: RNC, NEMA Type EPC-80-PVC for horizontal runs and RGS for horizontal sweeps in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits 600 V and Less and Smaller than 2-inch Diameter: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank with PVC Schedule 80 horizontal sweeps, unless otherwise indicated.
- D. Vertical Sweep Radius Abovegrade: GRC, for all locations/applications regardless of conduit size.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

3.02 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 1. Units in Driveway, Parking Lot, and Off-roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 fiberglass enclosures with polymer concrete

frame and cover, SCTE 77, Tier 15 fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.

2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.

3.03 EARTHWORK

- A. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
- C. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.04 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm), both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 26 05 44, Sleeves and Sleeve Seals for Electrical Raceways and Cabling.
- E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

- F. Pulling Cord: Install 100-pound per foot (445-N) test nylon cord in ducts, including spares.
- G. Concrete-encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 - 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - 6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
 - 7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
 - 8. Stub-ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise

indicated. Extend concrete encasement throughout the length of the elbow.

9. Detectable Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.05 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.06 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.07 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-fire-rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-pipe Sleeves: ASTM D 1785, Schedule 40.

- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or Molded-PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following.
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following.
 - a. Presealed Systems.
 - b. GPT – an EnPro Company.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5,000 psi (34.5 MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory-packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire-rated.
 - 2. Sealant shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in-place to produce a flexible, nonshrinking foam.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Sleeves for Conduits Penetrating Abovegrade Non-fire-rated Concrete and Masonry-unit Floors and Walls:
 - 1. Interior Penetrations of Non-fire-rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- C. Sleeves for Conduits Penetrating Non-fire-rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- D. Roof-penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- E. Aboveground, Exterior-wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- F. Underground, Exterior-wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Identification of power and control cables.
 - 2. Identification for conductors.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each electrical identification product indicated.

1.04 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.05 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other sections requiring identification applications, shop drawings, manufacturer's wiring diagrams, and the operation and maintenance

manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 inch to 2 inches (25 mm to 50 mm) wide.

2.02 FLOOR MARKING TAPE

- A. 2-inch (50-mm) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.03 UNDERGROUND-LINE WARNING TAPE

- A. Tape, Detectable Type:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 pounds per 1,000 square feet (13.7 kg/100 sq. m).
5. 3-inch (75-mm) Tensile According to ASTM D 882: 70 pounds per foot (311.3 N), and 4,600 psi (31.7 MPa).

2.04 WARNING LABELS AND SIGNS

A. All shall be black lettering on a white background.

B. Comply with NFPA 70 and 29 CFR 1910.145.

C. Self-adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

D. Baked-enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 inches by 10 inches (180 mm by 250 mm).

E. Metal-backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

F. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.05 EQUIPMENT IDENTIFICATION LABELS

- A. Self-adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with black letters on a white background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.06 CABLE TIES

- A. General-purpose Cable Ties: Fungus inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 Degrees F (23 degrees C), According to ASTM D638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 degrees F to 185 degrees F (minus 40 degrees C to 85 degrees F).
 - 4. Color: Black, except where used for color-coding.
- B. UV-stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 degrees F (23 degrees C), According to ASTM D638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 degrees F to 185 degrees F (minus 40 degrees C to 85 degrees C).
 - 4. Color: Black.

2.07 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum-rated.
- F. Underground-line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 inches to 8 inches (150 mm to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall.
- G. Painted Identification: Comply with requirements in painting sections for surface preparation and paint application.

3.02 IDENTIFICATION SCHEDULE

- A. Power-circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service and feeder conductors.
 - a. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - 5) Ground: Green.

- b. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
 - 5) Ground: Green.
 - c. Field-applied, Color-coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- B. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- C. Control-circuit Conductor Termination Identification: For identification at terminations provide wire marking labels with conductor designation.
- D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the operation and maintenance manual.
- E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- H. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch (10-mm) high letters for emergency instructions at equipment used for power transfer.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch (13-mm) high letters on 1-1/2-inch (38-mm) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label. Provide arc flash labels that are in compliance with NFPA 70E.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - e. Emergency system boxes and enclosures.
 - f. Enclosed switches.
 - g. Enclosed circuit breakers.
 - h. Variable-speed controllers.
 - i. Push-button stations.

- j. Power transfer equipment.
- k. Contactors.
- l. Remote-controlled switches, dimmer modules, and control devices.
- m. Power-generating units.
- n. Monitoring and control equipment.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1,000 kVA:
 - 1. General-purpose transformers.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - a. Wiring Diagrams: Power, signal, and control wiring.
- B. Informational Submittals:
 - 1. Qualification Data: For testing agency.
 - 2. Source quality-control test reports.
 - 3. Field quality-control test reports.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C57.12.91, “Test Code for Dry-Type Distribution and Power Transformers.”

1.05 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Corporation.
 - 2. Eaton Electrical Sector, Eaton Corporation; Cutler-Hammer products.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D C./Groupe Schneider NA, Schneider Electric.

2.02 GENERAL-PURPOSE TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.
- D. Encapsulation: In encapsulated transformers, the core-coil assembly is completely encased in a proportioned mixture of resin or epoxy, and aggregate to provide a moisture-proof, shock-resistant seal designed to completely seal out moisture and other contaminants.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Rated for environmental conditions at installed location.
 - 1. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 or Type 4X. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- F. Insulation Class: 220 degrees C, UL-component-recognized insulation system with a maximum of 115 degrees C rise above 40 degrees C ambient temperature.
- G. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
 - 3. Transformers shall comply with energy conservation standards specified in the Code of Federal Regulations at 10 CFR 431.196.
 - 4. Low-voltage encapsulated transformers may be excluded from the scope of U.S. Department of Energy, energy efficiency requirements.
- H. Wall Brackets: Manufacturer's standard brackets.
- I. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- J. Low-sound-level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.04 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 Identification for Electrical Systems.

2.05 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in-place and requirements in Section 26 05 26, Grounding and Bonding for Electrical Systems have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Section 26 05 29, Hangers and Supports for Electrical Systems.

3.03 CONNECTIONS

- A. Ground equipment according to Section 26 05 26, Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables.

3.04 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 16 PANELBOARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.03 DEFINITIONS

- A. SVR: Suppressed voltage rating.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 2. Shop Drawings: For each panelboard and related equipment.
 - a. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - b. Detail enclosure types and details for types other than NEMA 250, Type 1 or as indicated on Contract Drawings.
 - c. Detail bus configuration, current, and voltage ratings.
 - d. Short-circuit current rating of panelboards and overcurrent protective devices.
 - e. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - f. Include wiring diagrams for power, signal, and control wiring.
- B. Informational Submittals:
 - 1. Field Quality-control Reports:
 - a. Test procedures used.
 - b. Test results that comply with requirements.

- c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- 2. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

C. Closeout Submittals:

- 1. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, Operation and Maintenance Data, include the following:
 - a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - b. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

D. Maintenance Material Submittals:

- 1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Keys: Two spares for each type of panelboard cabinet lock.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NECA 407.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.08 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 or Type 4X.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Finishes:
 - a. Panels and Trim: Steel, factory-finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Bottom or top.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated copper.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated copper.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-configured Terminators: Mechanical type.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- G. All NEMA 1 type panelboard enclosures to be provided with door-in-door hinged assemblies.

2.02 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Eaton Electrical Inc., Cutler-Hammer Business Unit.
 - 2. General Electric Company, GE Consumer & Industrial – Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D, a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Refer to Drawings.
- E. Branch Overcurrent Protective Devices for all Circuit-breaker Frame Sizes: Bolt-on circuit breakers.

2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Eaton Electrical Inc., Cutler-Hammer Business Unit.
 - 2. General Electric Company, GE Consumer & Industrial – Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D, a brand of Schneider Electric.

- B. Molded-case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long-time and short-time pickup levels.
 - c. Long-time and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single-pole and two-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Ground-fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
 8. All circuit breakers shall be bolt-on type, the use of “push-on” type breakers is prohibited.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Mount top of trim 90 inches (2,286 mm) above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53, Identification for Electrical Systems.
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53, Identification for Electrical Systems.

- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53, Identification for Electrical Systems.

3.04 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION

SECTION 26 27 26 WIRING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Snap switches and wall-box dimmers.
 - 4. Wall-switch and exterior occupancy sensors.
 - 5. Communications outlets.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. UTP: Unshielded twisted pair.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.
 - 2. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- B. Informational Submittals: Field quality-control reports.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices, Division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated, Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seynour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

2.03 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Cooper; 5351 (single), CR5362 (duplex).
 - 2. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - 3. Leviton; 5891 (single), 5365 (duplex).
 - 4. Pass & Seynour; 5361 (single), 5362 (duplex).

2.04 GFCI RECEPTACLES

A. General Description:

1. Straight-blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following.
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

2.05 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A.

1. Products: Subject to compliance with requirements, provide one of the following.
 - a. Single-pole:
 - 1) Cooper; AH1221.
 - 2) Hubbell; HBL1221.
 - 3) Leviton; 1221-2.
 - 4) Pass & Seymour; CSB20AC1.
 - b. Two Pole:
 - 1) Cooper; AH1222.
 - 2) Hubbell; HBL1222.
 - 3) Leviton; 1222-2.
 - 4) Pass & Seymour; CSB20AC2.
 - c. Three-way:
 - 1) Cooper; AH1223.
 - 2) Hubbell; HBL1223.
 - 3) Leviton; 1223-2.
 - 4) Pass & Seymour; CSB20AC3.
 - d. Four-way:
 - 1) Cooper; AH1224.
 - 2) Hubbell; HBL1224.
 - 3) Leviton; 1224-2.
 - 4) Pass & Seymour; CSB20AC4.

2.06 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch (1-mm) thick, satin-finished, Type 302 stainless steel.
 - 3. Material for Damp Locations: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel listed and labeled for use in wet and damp locations.
- B. Wet-location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.
- C. Surface-mounted box cover plates shall be companion type of specific cast outlet box provided.

2.07 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that cover plate does not cross a joint, unless the joint is troweled flush with face of wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than 12 AWG are installed on 20-amp circuits, splice 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation: Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.

3.02 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

- A. Comply with Section 26 05 53, Identification for Electrical Systems.
- B. Identify each receptacle with panelboard identification and circuit number using tags behind faceplates.

END OF SECTION

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Nonfusible switches.
 - 2. Enclosures.
 - 3. Circuit breakers.

1.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single-pole, double-throw.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - a. Enclosure types and details for types other than NEMA 250, Type 1 or as indicated on Drawings.
 - b. Current and voltage ratings.
 - c. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - d. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - e. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

2. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - a. Wiring Diagrams: For power, signal, and control wiring.

B. Informational Submittals:

1. Field quality-control reports.
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Closeout Submittals:

1. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, Operation and Maintenance Data, include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated.
 1. Ambient Temperature: Not less than minus 22 degrees F (minus 30 degrees C) and not exceeding 104 degrees F (40 degrees C).
 2. Altitude: Not exceeding 1,000 feet (2,010 m).

1.07 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required

workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.01 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Eaton Electrical Inc., Cutler-Hammer Business Unit.
 - 2. General Electric Company, GE Consumer & Industrial – Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D, a brand of Schneider Electric.
- B. Type HD, Heavy-duty, Single-throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: One NO/NC (Form “C”) auxiliary contact(s), arranged to activate before switch blades open.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.02 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 2. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 3. Outdoor Wet or Damp Locations: NEMA 3R.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53, Identification for Electrical Systems.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 26 50 00 LED LIGHTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Canadian Standards Association (CSA).
2. Federal Communications Commission (FCC).
3. Illuminating Engineering Society of North America (IESNA).
 - a. HB-9, Lighting Handbook.
 - b. LM-79, IES Electrical and Photometric Measurements of Solid-State Lighting Products.
 - c. LM-80, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.
 - d. TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources.
4. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. National Electrical Manufacturers Association (NEMA).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC) – Softbound Version.
7. UL:
 - a. 844, Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
 - b. 8750, UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products - First Edition; Reprint with Revisions Through and Including April 1, 2015.
8. U.S. Environmental Protection Agency and U.S. Department of Energy: Energy Star.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. General:
 - 1) Provide catalog data sheets and pictures for all products listed below.

- 2) Proposed Luminaire Substitutions (Interior): Provide an electronic photometric file in standard '.ies' file format according to the Illumination Engineering Society of North America (IESNA) for any proposed luminaire substitution not identified on the project Luminaire Schedule. Obtain file from the luminaire manufacturer or approved independent photometric testing laboratory. Include the proposed substitute luminaire with all options identified on the project Luminaire Schedule.
- b. Interior Luminaires:
 - 1) Catalog data sheets with pictures.
 - 2) Luminaire material, finish, dimensions, and metal gauge.
 - 3) Lens material, pattern, and thickness.
 - 4) Candle power distribution curves in two or more planes.
 - 5) Candle power chart 0 degree to 90 degrees.
 - 6) Lumen output chart.
 - 7) Average maximum brightness data in foot lamberts.
 - 8) Coefficients of utilization for zonal cavity calculations.
 - 9) Mounting or suspension details.
 - 10) Heat exchange and air handling data.
- c. LED Source Systems:
 - 1) General:
 - a) IESNA LM-80 test reports.
 - b) IESNA TM-21 ratings.
 - c) Operating temperature range. Data sheet (chart/graph) describing life as a function of temperature.
 - d) Warranty: Light engine and driver.
 - e) Rated life.
 - f) Surge protection.
 - g) Thermal control device, heat sink.
 - h) Enclosure and wiring information.
 - i) Operating voltage range.
 - 2) Electronic Module/Light Engine:
 - a) Correlated color temperature (CCT).
 - b) Color rendering index (CRI).
 - 3) Drivers:
 - a) Input current total harmonic distortion.
 - b) Power factor.
 - c) Sound rating.
- d. Lighting Contractor:
 - 1) Type (mechanically or electrically held).
 - 2) Enclosure.
 - 3) Contact ratings and configuration.
 - 4) Coil operating voltage.

B. Informational Submittals:

1. Provide anchorage and bracing details.
2. Manufacturer's printed installation instructions.
3. Operation and maintenance data as specified in Section 01 78 23, Operation and Maintenance Data.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide 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. Provide materials and equipment manufactured within the scope of standards published by UL in conformance with those standards and with an applied UL listing mark.

B. Standard Products:

1. Provide materials and equipment of manufacturers regularly engaged in the production of products specified in this section and that are of equal material, design, and workmanship.
2. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to Bid opening in similar applications under similar circumstances and of similar size. Provide products that have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
3. Material and Equipment Manufacturing Date: Do not use products manufactured more than 3 years prior to date of delivery to Site.

PART 2 PRODUCTS

2.01 LUMINAIRES

- A.** Provide luminaires and components tested, listed, and labeled by UL, or other approved testing agency.
- B.** Provide luminaires with Illumination Engineering Society of North America (IESNA) formatted photometric files, ".ies" format, certified by the luminaire manufacturer for use with lighting software.
- C. Luminaire Labels:**
1. External label in accordance with ANSI C136.15.
 2. Internal label in accordance with ANSI C136.22.

D. Provide luminaires rated by the manufacturer to start and operate to their full lumen capacity for rated life of the luminaire at the minimum low and maximum high ambient temperatures as defined in the Contract Documents at their installation location.

E. Marine Environments:

1. UL-labeled: MARINE, OUTSIDE TYPE.
2. Housing: Copper-free, aluminum in accordance with UL 595.

2.02 LED SOURCE SYSTEMS

A. General:

1. Provide IESNA LM-80 test reports.
2. Provide Energy Star compliance for solid state luminaires.
3. Listed To: UL 8750 Standard for Safety for Light Emitting Diode (LED) Equipment for use in Lighting Products.
4. Provide RoHS compliant LED light source(s) and driver(s).
5. Warranty: 5 years minimum.
6. Luminaire used as basis for design, as manufactured by Nematlux; model XR-GEN-IP68. "Or-equal" is acceptable.

B. Electronic Module/Light Engine:

1. Mount all components to a single plate and factory prewired with quick-disconnect plugs.
2. Include a driver, thermal control device, thermal protector device, and surge protector device.
 - a. Provide surge protector tested according to IEEE/ANSI C62.41.2 to Category C Low.
3. Provide LEDs mounted to a metal-core circuit board and aluminum heat sink for optimal thermal management and long life.
4. Light Engine Rating: In accordance with TM-21: 100,000 at 25 degrees C, L70.
5. CCT: 5,000 K.
6. CRI: Minimum of 70.

C. Drivers:

1. Expected life of 100,000 hours at 25 degrees C.
2. Provide drivers mounted in an all-metal can.
3. Operating Voltage Range: 50/60-Hz input source of 120V to 277V with sustained variations of plus or minus 10 percent voltage with no damage to the driver.
4. Input Current Total Harmonic Distortion: Less than 20 percent up to 50 percent of full load rating.

5. Power Factor: Greater than 0.90 for primary application up to 50 percent of full load rating.
6. Sound Rating: Class A.
7. Comply with NEMA 410 for inrush current limits.

2.03 LIGHTING CONTROL

A. Lighting Contactor:

1. Features:
 - a. Electrically held contactor.
 - b. Contacts Rating: 120 volts, 30 amperes, and 12 poles.
 - c. Enclosure: NEMA 4 conforming to NEMA ICS 6.
 - d. Provide contactor with ON/OFF selector switch.
 - e. Provide hermetically sealed contactor.

2.04 BRACKETS AND SUPPORTS

- A. Features: Provide special mountings or brackets as indicated on Drawings fabricated of metal which will not promote galvanic reaction with luminaire head.

2.05 EQUIPMENT IDENTIFICATION

- A. Manufacturer's Nameplate: Provide each item of equipment with a nameplate bearing manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; nameplate of distributing agent will not be acceptable.
- B. Provide clear markings located to be readily visible to service personnel.

2.06 FACTORY FINISH

- A. Provide electrical equipment with factory-applied painting systems that, at minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper yoke as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
4. Install plumb and level.
5. Install each luminaire outlet box with galvanized stud.

B. Mounting:

1. General: Coordinate mounting, fastening, and environmental conditions to adjust to field requirements.
2. Wall-mounted: Measure mounting heights from center of mounting plate to finished floor or finished grade, whichever is applicable.

C. Finished/Unfinished Areas:

1. Wiring and Conduit:
 - a. Provide wiring of temperature rating required by luminaire.
 - b. Provide flexible steel conduit.
 - c. Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

3.02 LIGHTING CONTROL

- A. Outdoor Luminaires: Control of basin luminaires will be through a lighting enclosure with switch and lighting contactor as shown on the Drawings.

3.03 FIELD FINISHES

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of installation, verify equipment is properly installed, connected, and adjusted. Conduct an operating test to show equipment operates in accordance with the requirements of this section.
- B. Coordinate lighting and controls installation and testing with commissioning as specified in Section 01 91 14, Equipment Testing and Facility Startup.

3.05 CLEANING

- A. Remove labels and markings, except UL listing mark.
- B. Wipe luminaires inside and out to remove construction dust.
- C. Clean luminaire plastic lenses with antistatic cleaners only.
- D. Touch up painted surfaces of luminaires with matching paint ordered from manufacturer.
- E. Replace defective lamps at time of Substantial Completion.

3.06 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Luminaire Schedule.

END OF SECTION

Luminaire Schedule						
Type	Voltage	Description	Manufacturer	Catalog No.	Lamp Type	Mounting Type
LED	277	LED luminaire	Nemalux	XR-GEN-IP68	LED	Wall

SECTION 33 13 00
DISINFECTION OF WATER UTILITY 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 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 New Jersey, 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. Piping.
 - b. Treatment plant basins and processes used to supply water to system.

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. Owner will supply potable quality water. Contractor shall convey in disinfected pipelines or containers. Make arrangements for water supply and convey water in disinfected pipelines or containers.

2.03 DISINFECTANT

- A. The following disinfectant product(s) shall not be used: Liquid chlorine as defined under AWWA B301.

PART 3 EXECUTION

3.01 GENERAL

- A. Conform to AWWA C653 for water treatment plants and filters, except as modified in these Specifications.
- B. Contractor's Equipment: Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
- C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
 - 1. Tanks.
 - 2. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
 - 3. 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 tank 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.

3.03 PIPING

- 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.
- B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.04 TANKS AND RESERVOIRS

- A. Cleaning:
1. Clean interior surfaces using water under pressure before sterilizing.
 2. Isolate tank from system to prevent contaminating materials from entering distribution system.
 3. Cleaning shall:
 - a. Remove deposits of foreign nature.
 - b. Remove biological growths.
 - c. Clean slopes, walls, top, and bottom.
 - d. Avoid damage to structure.
 - e. Avoid pollution or oil deposits by workers and equipment.
 4. Dispose of water used in cleaning in accordance with applicable regulations before adding disinfecting solution to tank.
- B. Disinfecting Procedure: In accordance with AWWA C653, unless herein modified. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.

3.05 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.

3.06 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:

1. Collect and analyze samples in accordance with applicable AWWA standard.
2. Analysis to be performed by an independent test laboratory. Samples will be analyzed using amperometric titration method for free chlorine as described in latest edition of Standard Methods for Examination of Water and Wastewater.

D. After tanks, 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.
3. Obtain and analyze a minimum of two samples on each of 2 consecutive days from each separable structure and every 1,000 feet of pipeline by standard procedures outlined by state and local regulatory agencies.
4. Sampling points shall be representative and accepted by Engineer.

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 35 20 16.25
STOP LOGS

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. C561, Fabricated Stainless Steel Slide Gates.
 - b. C562, Fabricated Aluminum Slide Gates.
2. ASTM International (ASTM):
 - a. A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - b. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
 - c. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - d. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - e. B209, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - f. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
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 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Make, model, and weight of each equipment assembly.
 - b. Manufacturer's catalog information, descriptive literature, and specifications Provide complete description of all materials of construction including the material thickness of all structural components of the stop logs, guide frames and stop log lifter.
 - c. Installation drawings showing all details of construction, details required for installation, dimensions and anchor bolt locations.

- d. Maximum bending stress and deflection of stop logs under the maximum design head.
- e. Performance test procedures.

B. Informational Submittals:

- 1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
- 2. Certification for compliance to NSF/ANSI 61.
- 3. Special shipping, storage and protection, and handling instructions.
- 4. Manufacturer's written/printed installation instructions.
- 5. Routine maintenance requirements prior to installation.
- 6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
- 7. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.03 QUALITY ASSURANCE

- A. Qualifications: All of the equipment specified under this section shall be furnished by a single manufacturer with a minimum of 10 years' experience designing and manufacturing stop logs. The manufacturer shall have manufactured stop logs for a minimum of 100 projects.

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.
- B. Stop log assemblies shall be as specified herein and have the characteristics and dimensions shown on the Contract Drawings.
- C. Stop logs shall be provided with a continuous resilient seal along the bottom and both sides. Guide frames shall not incorporate seals.
- D. Stop logs shall be of the height as shown in the Contract Drawings and they shall be designed to function properly when stacked in any order.

- E. Stop logs shall be designed to drop into place under their own weight without any downward pressure necessary. Stacking stop plates are not acceptable in lieu of stop logs.
- F. All structural components of the stop logs shall be fabricated of aluminum and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.
- G. All guide frame structural components shall be fabricated of stainless steel and shall have adequate strength to prevent distortion during normal handling, during installation, and while in service.
- H. All welds shall be performed by welders with AWS certification.

2.02 MATERIALS

- A. Aluminum Plate and Shapes: ASTM B209, ASTM B221, and ASTM B308/B308M, Alloy 6061-T6.
- B. Stainless Steel:
 - 1. Plate, Sheet, and Strip: ASTM A240/A240M, Type 304L.
 - 2. Bars and Shapes: ASTM A276, Type 304L.

2.03 PERFORMANCE REQUIREMENTS

- A. Leakage shall not exceed 0.05 gallon per minute per liner foot of wetted seal perimeter.

2.04 ALUMINUM STOP LOGS

- A. Stop Log Service Conditions: See Table 1 for locations and specific service conditions.
- B. Stop Logs:
 - 1. Stop logs shall be constructed of extruded aluminum shapes with a minimum thickness of 5/16-inch.
 - a. Each stop log shall have a nominal height of 12 inches unless otherwise indicated on the Contract Drawings and Table 1 or approved by the Engineer during submittal review.
 - b. Maximum bending stress shall not exceed 7,600 psi at maximum operating head.
 - c. Adequate drainage shall be provided for each stop log.
 - d. Two slots shall be provided in the top of each stop log for removal and installation via the stop log lifter.

- e. Each stop log shall be outfitted with an identification tag indicating the manufacturer, width of the opening and maximum head rating at a minimum. Additional tags shall be included on each stop log that indicate “dry side” and “wet side.” Tags shall be welded to each log.
- f. Dimensions included in Table 1 below are from record drawings and must be field verified by the Contractor before submitting product data.

Table 1			
Location	Design Criteria		
	Basin Influent Conduit	Basin Effluent Conduit	Filter Influent Conduit
Nominal channel width, inches	See Structural Drawing	See Structural Drawing	See Structural Drawing
Nominal guide height, feet	See Structural Drawing	See Structural Drawing	See Structural Drawing
Invert elevation, feet	316.00	305.00	315.5
Design head, feet	5.53	16.18	5.66
Guide frame quantity	2	8	4
Total number of logs	6	68	12

C. Guide Frames:

1. Frame guides or grooves and invert member shall be constructed of Type 304L stainless steel with a minimum thickness of 1/4-inch.
 - a. Frame design shall allow for embedded mounting or mounting directly to a wall with stainless steel anchor bolts and grout. Mounting style shall be as shown on the Contract Drawings.
 - b. An invert member shall be provided across the bottom of the guides. The invert member shall be of the flush-bottom type.
 - c. Frame-mounted seals are not acceptable.

D. Seals:

1. Each stop log shall be outfitted with a continuous resilient lip seal along the bottom and both sides to restrict leakage in accordance with the requirements listed in this Specification.
 - a. The continuous lip seal shall be constructed of urethane or rubber and shall be mechanically retained to the stop log.
 - b. The lip seal shall be activated by a combination of the weight of the stop log and the differential water pressure, which pushes the seal against the inside of the groove assembly.

- E. Anchor Bolts and Hardware: All necessary attaching bolts, anchor bolts, mounting and assembly hardware shall be Type 316 stainless steel and shall be furnished by stop log manufacturer.
- F. Lifting Devices:
 - 1. One stop log lifter shall be provided for each different guide frame width.
 - a. The lifter shall be constructed of aluminum and shall be outfitted with UHMW guide bars and stainless steel fasteners.
 - b. The lifter shall be provided with lifting hooks designed to engage the slots in the top of the stop logs. A lanyard release will be incorporated into the design.
 - c. The lifter shall be capable of installing and removing all stop logs of the same width whether they are installed or at the operating floor level.
- G. Storage Racks:
 - 1. Provide stop log storage racks sized to store total number of specified logs for areas indicated on Table 1.
 - 2. Final configurations and locations of racks shall be approved by Engineer.
- H. Manufacturers:
 - 1. Whipps, Inc.
 - 2. Rodney Hunt Co.
 - 3. H. Fontaine, Ltd.
 - 4. Hydro Gate Corp.

2.05 APPURTENANCES

- A. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.
- B. Anchor Bolts: ASTM A193/A193M, Type 316 stainless steel sized by equipment manufacturer at least 1/2 inch in diameter, or as shown, and as specified in Section 05 05 19, Post-Installed Anchors.

2.06 SHOP/FACTORY FINISHING

- A. Mechanically descale and passivate all weld burn and weld slag in accordance with ASTM A380 to provide uniform finish.
- B. All aluminum surfaces in contact with concrete shall be insulated with suitable protective neoprene gasket material.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with the manufacturer's written instructions.
- B. Accurately place anchor bolts using templates furnished by the manufacturer.

3.02 FIELD QUALITY CONTROL

- A. Functional Tests: Stop logs shall be installed in guide frame and visually inspected for proper orientation and sealing of gaskets before conducting performance test.
- B. Performance Test:
 - 1. Conduct on each stop log assembly.
 - 2. Perform under actual or approved simulated operating conditions.
 - 3. Test for a continuous 24-hour period without malfunction.
 - 4. Adjust, realign, or modify units and retest if necessary.
 - 5. Leakage must be below acceptable levels before placing into service.

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 for installation assistance and inspection.
 - 2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1 person-day for training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.
- C. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

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 (Galvannealed) by the Hot-Dip Process.
 - c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
 - a. International Building Code (IBC).
 - b. International Mechanical Code (IMC).
5. 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 and 4 inches and smaller. 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.

B. Informational Submittals: Maintenance information on piping support system.

1.04 QUALIFICATIONS

- A. Piping support systems shall be designed, and shop drawings prepared and sealed by a professional engineer registered in the State of New Jersey.

1.05 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.

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.
3. Electrical Conduit Support: Include in design of framing support system.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

- E. 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: In accordance with Table 1, attached as supplement at end of section.

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.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchor bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

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 FRP PIPE SUPPORTS SYSTEMS

- A. General:
 - 1. FRP with UV additive, protective veil, and vinyl ester resins.
 - 2. Fire Retardant: ASTM E84.
 - 3. Include hangers, rods, attachments, and fasteners.
- B. Clevis Hangers:
 - 1. Factor of Safety: 3 to 1.
 - 2. Minimum Design Load: 200 pounds.
- C. Design:
 - 1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
 - 2. Identify and highlight nonFRP fasteners or components in Shop Drawing.
- D. Manufacturers:
 - 1. Aickinstrut.
 - 2. Enduro.
 - 3. Century Composite.

2.07 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.

2.08 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.

2.09 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.

2.10 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.

2.11 PIPE ANCHORS

- A. Type: Anchor chair with U-bolt strap.
- B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 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.

2.13 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, 1/2-inch minimum diameter, 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.

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 lateral supports for seismic loads at changes in direction.
 - 11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
 - 12. 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.
 - 2) 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).
 - 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.
 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 to 120-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.

3.02 FIELD FINISHING

- A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is part of this specification:

1. Table 1: Nonchemical Areas.

END OF SECTION

Table 1 Nonchemical Areas	
Exposure Conditions	Support Material
Pipe galleries	Galvanized steel or precoated steel, plastic-coated hangers for uninsulated copper or stainless steel piping
Process Areas: High humidity or hydrogen sulfide	Stainless steel or FRP
Process Areas: Wetted or submerged	Stainless steel or FRP
Notes: <ol style="list-style-type: none"> 1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol). 2. Stainless steel to be Type 304. 3. Galvanized steel to be according to ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M. 4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces. 	

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 Personnel 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.
 - l. 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.
- lll. 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.
- ooo. 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. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
- 12. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
- 13. NSF International (NSF):
 - a. ANSI 61: Drinking Water System Components - Health Effects.
 - b. ANSI 372: Drinking Water System Components - Lead Content.

1.02 DEFINITIONS

A. Submerged or Wetted:

- 1. Zone below elevation of:
 - a. Liquid surface or within 2 feet above top of liquid surface.
 - b. Top of tank wall or under tank cover.

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. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
 2. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
 3. 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: 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.
- 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. Flanged Pipe and Fittings: Manufacturer's product data sheets for gaskets including torquing requirements and bolt tightening procedures.
 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. Nondestructive inspection and testing procedures.
- 5. Test logs.
- 6. Pipe coating applicator certification.
- 7. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
- 8. CWI inspection records and NDE test records.

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 AWS D1.6/D1.6M (Annex H Forms).
- 3. AWS D1.6/D1.6M (Annex H 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.

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 sheets located at the end of this section as Supplement and on Piping Schedule located on 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. Grooved-end System:
1. Rigid type.
 2. Use of flexible grooved joints allowed where shown on Drawings or with prior approval by Engineer.
 3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved-end couplings.

B. 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.

C. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

D. 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.
 - 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.

E. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
 - a. Pipeline Products Corp.
 - b. Fernco Joint Sealer Co.

F. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
4. Gaskets as specified on data sheet.

2.04 GASKET LUBRICANT

- A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.05 DOUBLE WALL CONTAINMENT PIPING SYSTEM

- A. System components shall be pre-engineered, factory-fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.06 PIPE CORROSION PROTECTION

- A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.
- B. Insulating Flanges, Couplings, and Unions:
 - 1. Materials:
 - a. In accordance with applicable piping material specified in pipe data sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
 - b. Galvanically compatible with piping.
 - c. Resistant for intended exposure, operating temperatures, and products in pipeline.
 - 2. Union Type, 2 Inches and Smaller:
 - a. Screwed or solder-joint.
 - b. O-ring sealed with molded and bonded insulation to body.
 - 3. Flange Type, 2-1/2 Inches and Larger:
 - a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
 - b. Bolt insulating sleeves shall be provided full length between insulating washers.
 - c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
 - d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
 - e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
 - 4. Flange Insulating Kits:
 - a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
 - b. Insulating Sleeves: Full-length Mylar.
 - c. Insulating Washers: High-strength phenolic.
 - d. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
 - 1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
 - 2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.

- 5. Manufacturers and Products:
 - a. Dielectric Flanges and Unions:
 - 1) PSI, Houston, TX.
 - 2) Advance Products and Systems, Lafayette, LA.
 - b. Insulating Couplings:
 - 1) Dresser; Style 39.
 - 2) Baker Coupling Company, Inc.; Series 216.

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. 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 supplements to this section and Piping Schedule shown on Drawings.
- B. Galvanizing:
 - 1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
 - 2. Electroplated zinc or cadmium plating is unacceptable.
 - 3. Stainless steel components may be substituted where galvanizing is specified.

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 AWS D1.6/D1.6M.
- 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.
- 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 defects 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 or grooved joint flange adapter 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. Grooved-end Joints:

1. Piping shall be grooved in accordance with manufacturer's latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer's standards and to AWWA C606.
2. Install grooved joint couplings and gaskets in accordance with manufacturer's latest published installation instructions.

F. Brazed Joints for Refrigerant Piping:

1. Braze copper piping with silver solder complying with AWS A5.8/A5.8M.
2. Construct joints according to AWS Brazing Handbook, Chapter Pipe and Tube.
3. Inside of tubing and fittings shall be free of flux.
4. Clean parts to be joined with emery cloth and keep hot until solder has penetrated the full depth of the fitting and extra flux has been expelled.
5. Cool joints in air and remove flame marks and traces of flux.
6. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel the air.
7. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

G. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

H. 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.

I. 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.
 - d. Flexible Couplings, Flanged Coupling Adapters, and Grooved-end Pipe Couplings: As recommended by the coupling or adapter manufacturer.

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 1 inch 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—CONCRETE-ENCASED

- A. Provide reinforced concrete pipe encasement where shown on 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 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.

3.07 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. 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. Carbon Steel Pipe:
 1. Exposed: As specified in Section 09 90 00, Painting and Coating.
 2. Submerged or Embedded: Shop 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.
- C. Copper Pipe:
 1. Exposed: As specified in Section 09 90 00, Painting and Coating.
- D. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

E. 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.

F. Insulating Flanges, Couplings, and Unions:

1. Applications:
 - a. Dissimilar metal piping connections.
 - b. Cathodically protected piping penetration to buildings and watertight structures.
 - c. Submerged to unsubmerged metallic piping connections.
 - d. Where required for electrically insulated connection.
2. Pipe Installation:
 - a. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
 - b. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.08 THRUST RESTRAINT

A. Location:

1. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
2. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

3.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

- A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.10 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.

3.11 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 at all low and high-point locations.

3.12 DISINFECTION

- A. See Section 33 13 00, Disinfection of Water Utility Facilities.

3.13 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.

3.14 PIPE IDENTIFICATION

- A. As specified in Section 09 90 00, Painting and Coating.

3.15 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 AWS D1.6/1.6M but no less than 10 percent of all welds.
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.

3.16 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 instrument air lines with compressed air at 4,000 fpm; do not flush with water.
- C. Immediately after cleaning 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.

3.17 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar-Lined Ductile Iron Pipe and Fittings
40 27 00.07	Galvanized Steel Pipe and Malleable Iron Fittings
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings

END OF SECTION

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
General	<p>Materials in contact with potable water shall conform to NSF 61 acceptance.</p> <p>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).</p>
Pipe	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	<p>Lined and coated same as pipe.</p> <p>Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat-face or ASME B16.1, Class 250 raised-face. Gray cast iron will not be allowed.</p>
Joints	<p>Flange: Dimensions per AWWA C110/A21.10 flat face, or ASME B16.1 Class 250 raised face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.</p> <p>Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.</p>
Couplings	<p>Grooved-end: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p> <p>Grooved-end Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p>
Bolting	<p>Mechanical, Proprietary Restrained, and Grooved-end Joints: Manufacturer's standard.</p> <p>Flanged: 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. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</p>

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
Gaskets	<p>General: Gaskets in contact with potable water shall be NSF ANSI 61 certified.</p> <p>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.</p> <p>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.</p> <p>Gasket pressure rating to equal or exceed the system hydrostatic test pressure.</p>
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.07 GALVANIZED STEEL PIPE AND MALLEABLE IRON FITTINGS		
Item	Size	Description
Pipe	1-1/2" & smaller 2" thru 6" 8" thru 12" 14"	Galvanized carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53, Grade B seamless or ERW. Standard weight. Standard weight. Standard weight. Standard weight.
Joints	1-1/2" & smaller 2" & larger	Threaded or flanged at valves and equipment, or grooved end meeting requirements of AWWA C606. Flanged at valves and equipment, or grooved end meeting requirements of AWWA C606.
Fittings	1-1/2" & smaller 2" & larger	Threaded: 150-pound or 300-pound malleable iron, ASTM A197A197M or ASTM A47/A47M, dimensions in accordance with ASME B16.3. Grooved End: Malleable iron ASTM A47/A47M or ductile iron ASTM A536, 250 psi working pressure, grooved ends to accept couplings without field preparation. Victaulic; Anvil International, Inc., Gruvlok.
Branch Connections	1-1/2" & smaller 2" & larger	Tee or reducing tee in conformance with Fittings above, galvanized 2,000-pound WOG threadolet or welding boss; galvanize after welding. Branch Same Size as Run: Grooved-end tee in accordance with Fittings above. Branch One or More Sizes Smaller Than Run: Grooved-end reducing tee in accordance with Fittings above.
Flanges	1-1/2" & smaller	Galvanized, forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5 Class 150 or Class 300, socket-weld or threaded, 1/16-inch raised face.

SECTION 40 27 00.07 GALVANIZED STEEL PIPE AND MALLEABLE IRON FITTINGS		
Item	Size	Description
	2" & larger	<p>Butt-welded Systems Standard Flange (RFWN): Galvanized, forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, 1/8-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.</p> <p>Butt-welded Systems Standard Flange (FFWN): Galvanized, forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, 1/8-inch flat face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.</p> <p>Butt-welded Systems Blind Flange: Galvanized, forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150, 1/8-inch flat face.</p> <p>Grooved-end Adapter Flange: Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic Style 741 or 743; Anvil International, Inc., Gruvlok Figure 7012 or 7013; Shurjoint Model 7041-A. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.</p>
Unions		Threaded malleable iron, ASTM A197/A197M or ASTM A47/A47M, 300-pound WOG, brass to iron seat, meeting the requirements of ASME B16.3.
Couplings		Grooved-end: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536, 250 psi working pressure. Victaulic; Anvil International, Inc., Gruvlok.
Plugs		Forged carbon steel, ASTM A181/A181M, Grade II, round head, threaded, galvanized.

SECTION 40 27 00.07		
GALVANIZED STEEL PIPE AND MALLEABLE IRON FITTINGS		
Item	Size	Description
Bolting		<p>Grooved-end Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength.</p> <p>Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.</p>
Gaskets	<p>All flanges</p> <p>Grooved end couplings</p>	<p>Flanged, Water and Sewage Service: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21, ASTM D1330, Steam Grade.</p> <p>Blind Flanges: Gasketed covering entire inside face with gasket cemented to blind flange.</p> <p>Insulating Gasket ASME B16.21 and ASME 16.5, fabric-reinforced phenolic neoprene faced gasket, sleeves, washers, CL150, 1/8-inch thick, 175 degrees F Step-Ko Type ‘E’ DW or approved equal.</p> <p>EPDM or chlorinated butyl per ASTM D2000 for water, and air to 230 degrees F, dimensions conforming to AWWA C606.</p>
Thread Lubricant	1-1/2" & smaller	Teflon tape or joint compound that is insoluble in water.

END OF SECTION

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. With Raised-face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel 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.

SECTION 40 27 00.10 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. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon tape.

END OF SECTION

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: Manufacturer's data on materials, construction, end connections, ratings, overall lengths, head losses (as applicable), and live lengths (as applicable).

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.

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 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 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 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. Flexible Sleeve Type Coupling:
1. Manufacturers and Products:
 - a. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 253.
 - 2) Smith-Blair, Inc.; Style 441.
- C. Flanged Coupling Adapter:
1. Anchor studs where required for thrust restraint.
 2. Manufacturers and Products:
 - a. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 128.
 - 2) Smith-Blair, Inc.; Style 912.
- D. 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.
- E. Restrained Dismantling Joints:
1. Pressure Rating:
 - a. Minimum working pressure rating shall not be less than rating of the connecting flange.
 - b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
 2. Manufacturers and Products:
 - a. Dresser Piping Specialties; Style 131.
 - b. Smith Blair, Inc.; Model 975.

F. Exposed Metallic Piping Plain-end Couplings:

1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, "or-equal."

2.03 EXPANSION JOINTS

A. Teflon Bellows:

1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
 - a. Garlock; Style 215.
 - b. Resistoflex; No. R6905.
 - c. Unisource Manufacturing, Inc.; Style 113.
 - d. Proco Products, Inc.; Series 443.

B. 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 3/4 inches.
6. Manufacturers and Products:
 - a. U.S. Bellows, Inc.; Universal Tied expansion joint.
 - b. Metraflex, Model MN.
 - c. Senior Flexonics Pathway, Inc.; Expansion Joints.

C. Galvanized and Black Steel Pipe Expansion Compensator:

1. Material: Carbon steel with stainless steel bellows.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.

4. Manufacturers and Products:
 - a. Senior Flexonics.
 - b. Hyspan; Model 8503.
 - c. Unisource Manufacturing, Inc.; Style EC-MMT.

2.04 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.

B. Nylon-coated 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. Materials:
 - a. Body: Nylon-coated iron.
 - b. Seal: Buna-N.
 - c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315 or Style 317.

2.05 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.

2.06 WASH DOWN MONITOR

A. Single Waterway Monitor:

1. Flow: 1,250 gpm.
2. Head Loss: Not to exceed 10 psi at 800 gpm.
3. All brass construction.
4. 3-inch waterway.
5. 4-inch flanged inlet connection.
6. 2-1/2-inch male NH thread discharge.
7. Control Options: Tiller bar.
8. Vertical travel lock shall incorporate a friction lock within the swivel joint.
9. All elbows shall have cast-in turning vanes.
10. Monitor shall have a vertical travel of 150 degrees and horizontal travel of 360 degrees.
11. Provide a monitor nozzle for each single waterway monitor as specified.
12. Manufacturer's and Products:
 - a. Akron Brass Company; Style 3526.
 - b. "Or-equal."

B. Monitor Nozzle:

1. Plain-tip type.
2. Brass construction.
3. Maximum Operating Pressure: 100 psi.

4. 2-1/2-inch female NH thread inlet.
5. Length: 9 inches.
6. Orifice: 1-1/2 inches.
7. Finish: Polished.
8. Manufacturer and Product: Dixon Valve; BMT1100-250F-P.

2.07 MISCELLANEOUS SPECIALTIES

A. Water Hose:

1. Furnish 50-foot lengths of 1-inch and 50-foot lengths of 1-1/2-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
 - a. Goodyear.
 - b. Boston.

B. Hose Nozzles:

1. Furnish 1-inch and 1-1/2-inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.
2. Manufacturers:
 - a. Croker.
 - b. Elkhart.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide accessibility to piping specialties for control and maintenance.

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 or in accordance with NFPA 24.
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: 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 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. Remove pipe coating if necessary to present smooth surface.
 4. Application:
 - a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
 - b. Concrete-encased Couplings: Flexible coupling.

3.07 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.

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.
 - l. C550, Protective Interior Coatings for Valves and Hydrants.
 - m. C606, Grooved and Shouldered Joints.
 - n. C800, Underground Service Line Valves and Fittings.

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.
 - l. 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.
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.

B. Informational Submittals:

1. 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.
2. Tests and inspection data.
3. Manufacturer's warranty.
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.

1.03 WARRANTY

- A. Provide manufacturer's warranty as specified in these Contract Documents.

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 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 supplement to this section.

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.
 - 1. 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. Gate Valves:

1. General:
 - a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
 - 1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
 - 2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
 - 3) Provide Affidavit of Compliance in accordance with the applicable AWWA standard for AWWA gate valves.
 - 4) Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
 - 5) Repaired AWWA gate valves shall not be submitted or supplied.
 - 6) Supply AWWA gate valves with stainless steel bolting.
 - 7) AWWA C509 and AWWA C515 valves may be substituted for each other.
 2. Type V130 Resilient Seated Gate Valve 3 Inches to 12 Inches:
 - a. Iron body, resilient seat, bronze stem and stem nut, ASME B16.1 Class 125 flanged ends, nonrising stem, in accordance with AWWA C509, minimum design working water pressure 200 psig, full port, fusion-epoxy coated inside and outside in accordance with AWWA C550, NSF/ANSI 61 certified.
 - b. Manufacturers and Products:
 - 1) M&H Valve; AWWA C509.
 - 2) U.S. Pipe; A-USPO.

B. Globe Valves:

1. Type V237 Angle Pattern Hose Valve 1 Inch to 2 Inches:
 - a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, brass cap with chain, complies with MSS SP-80, rated 300 WOG.
 - b. Manufacturers and Products:
 - 1) Stockham; Figure B-222T.
 - 2) Crane Co.; Cat. No. 17TF.
 - 3) Nibco; Figure T-335-Y.

C. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
 - a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
 - b. Manufacturers and Products:
 - 1) Threaded:
 - a) Conbraco Apollo; 70-100.
 - b) Nibco; T-580-70.
 - 2) Soldered:
 - a) Conbraco Apollo; 70-200.
 - b) Nibco; S-580-70.
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 body, ball, and stem, end entry, double union design, solvent-weld socket ends, 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.
3. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
 - a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru-Bloc.
 - 2) ASAHI/America; Type 21.

D. Plug Valves:

1. Type V400 Eccentric Plug Valve 2 Inches and Smaller:
 - a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, threaded ends, lever operator, cast-iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber.

- b. Manufacturers and Products:
 - 1) Pratt; Ballcentric.
 - 2) DeZurik; Style PEC.
 - 3) Milliken; Millcentric Series 603.
- 2. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
 - a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends in accordance with ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.
 - b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
 - c. For buried service, provide external epoxy coating.
 - d. Operators:
 - 1) 3-inch to 4-inch Valves: Wrench lever manual.
 - 2) 6-inch to 12-inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
 - 3) Provide an extension spindle where shown on the Drawings. Extension spindle shall be suitable for installation of either manual or electric motor actuators as scheduled. Extension spindle shall extend 2 feet -6 inches above the operating floor for installation of and convenient access to electric motor operators or handwheels, as applicable. Spindle shall be enclosed to prevent contact with moving parts and have mounts for support and attachment of manual or electric motor operators.
 - e. Manufacturers and Products:
 - 1) Pratt; Ballcentric.
 - 2) DeZurik; Style PEC.
 - 3) Milliken; Millcentric Series 600.

E. 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.
 - 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 in accordance with AWWA, unless otherwise indicated on 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 Drawings or specified herein.
2. Type V540 Rectangular Butterfly Valve:
- a. Design:
 - 1) Four-sided seating.
 - 2) Valve shall be bubble tight at rated pressures with flow in either direction.
 - 3) Shall be capable of operation after long periods of inactivity.
 - 4) Valve discs shall rotate 90 degrees from the full open to the tight-shut position.
 - 5) When subjected to the maximum design head, a stress safety factor shall 3.0 and the yield point of 5.0 on the ultimate strength whichever is lower, shall not be exceeded.
 - 6) Maximum deflection of the valve structural design limit is 1/16-inch.
 - 7) Leakage under specified conditions shall be cause for rejection.
 - b. Construction:
 - 1) Dimensions: Refer to the Drawings.
 - 2) Body: Fabricated ASTM A36 carbon steel or cast iron with upper trunnion recess bored for Teflon impregnated packing.
 - 3) Disc:
 - a) Carbon Steel: ASTM A36.
 - b) Disc shall be streamlined in shape to prevent turbulence in the full open position and to minimize pressure drop across the valve.
 - c) No external ribs transverse to the flow.

- 4) Shaft:
 - a) Type 304 stainless steel.
 - b) Stainless steel taper pin anchorage mechanically secured.
 - c) Extend 1.5 diameters, minimum, into disc.
- 5) Body Seat:
 - a) 40 durometer to 50 durometer synthetic rubber.
 - b) Stainless steel seat retainers permitting at least 1/8-inch adjustment.
 - c) Shall be fully field adjustable and replaceable without dismantling the actuator, disc, or shaft without the use of special tools and without special processes (chipping, grinding, or burning out of the old seat) and shall be adjustable from both sides of the disc.
 - d) Corner radii shall not exceed 6 inches.
- 6) Disc Seating Edge:
 - a) Type 304 stainless steel, contoured, ground, and polished.
 - b) Sprayed or plated edges not acceptable.
- 7) Main Shaft Bearing:
 - a) Self-lubricated sleeve type.
 - b) Fiberglass-backed Teflon.
 - c) 4000 psi maximum bearing stress.
- 8) Thrust Bearing:
 - a) Two-way type.
 - b) Designed to hold disc centered in valve seat at all times.
 - c) Shall be secured by a locking device, located in the top trunnion of the valve body and easily accessible for field adjustment from the actuator end of the valve.
- 9) Shaft Seal:
 - a) Stuffing box and packing gland or split-vee, self-adjusting type.
 - b) Square type packing.
 - c) Packing shall be adjustable and completely replaceable without disturbing any part of the valve or actuator assembly.
- 10) Actuator: Shall be sized to operate the valve with the maximum torque encountered along the operation of the valve from full open to full closed including seating and unseating head conditions with a factor of safety of 2.0.

- c. Mounting:
 - 1) Shall be suitably designed for each installation method as shown on the Drawings.
 - a) A36 carbon steel coated in accordance with Section 09 90 00, Painting and Coating or ductile iron wall thimble.
 - b) Channel-mounted:
 - (1) Permanent multiple bolting shall not be acceptable.
 - (2) Shall have flanges drilled in accordance with the template of the frame to which it is bolted.
- d. Manufacturer:
 - 1) Henry Pratt Co.
 - 2) "Or-equal."

F. Miscellaneous Valves:

- 1. Type V915 Mud Valve 4 Inches to 24 Inches:
 - a. Cast-iron frame, yoke, and gate; heavy-duty 125-pound flange style, bronze seat, Buna-N seal, nonrising stem, bronze stem and stem nut, 2-inch square operating nut, cast-iron floor box, Type 304 stainless steel extension stem; stem guides spaced for L/R of 200 maximum.
 - b. Manufacturers:
 - 1) Troy Valve.
 - 2) Trumbull Industries, Inc.
 - 3) Clow Valve Company.
- 2. Type V930 Fire Hydrant: (Describe agency standard.)

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 Operators, 120 Volts:

1. General:
 - a. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of the valve.
 - b. Provide operator mounting bracket to mount operator to valve providing minimal torque to piping system when operating.
2. Operator Operation, General:
 - a. Suitable for full 90-degree rotation of quarter-turn valves.
 - b. Manually override handwheel.
 - c. Mechanical valve position indication.
3. Electronic Control:
 - a. Torque Limiting Switches: Two single-pole, double-throw (SPDT) mechanical switches. Switches operate at any point in valve travel.
 - b. Jammed-valve detection and protection.
 - c. Motor over-temperature detection and protection.
 - d. Travel limit switches, SPDT.
4. Open-Close (O/C) Service:
 - a. Duty cycle for intermittent ON-OFF operation shall be 25 percent.
 - b. Operator shall power to OPEN and power to CLOSE.
 - c. Local Indication and Control:
 - 1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
 - 2) Integral OPENED and CLOSED indication lights.
 - 3) Integral LOCAL-OFF-REMOTE (L-O-R).
 - 4) Integral OPEN maintained switch which causes the valve to stroke full OPENED, even if OPEN switch is released, while L-O-R switch is in LOCAL.

- 5) Integral CLOSE maintained switch which causes valve to stroke full CLOSED, even if CLOSED switch is released, while L-O-R switch is in LOCAL.
 - d. Actuator Requirements for SCADA:
 - 1) Plug valves are to be equipped with motorized actuators, suitable for the valve.
 - 2) Actuators shall be equipped with a L-O-R selector, along with Open-Stop-Close pushbuttons.
 - 3) Actuators for V405 plug valves shall be equipped with a ProfiBus DP interface.
 - 4) Signals required over ProfiBus to/from SCADA include:
 - a) Valve in Remote (from L-O-R selector).
 - b) Valve Actuator Fault.
 - c) Command to Open Valve from SCADA.
 - d) Command to Close Valve from SCADA.
 - e) Valve Opened Status to SCADA.
 - f) Valve Closed Status to SCADA.
 - 5) In the event of a ProfiBus signal loss or an actuator fault, the valve shall stay in its current position, and not default to the full-open or full-closed position.
 5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule supplement to this section.
 6. Manufacturer and Product:
 - a. Rotork Controls; IQ/IQT Series.
 - b. "Or-equal."
- C. 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.
 - e. Nonintrusive Electronic Control: Local controls, diagnostics, and calibration, including limit and torque settings, shall be

accomplished nonintrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two, minimum.

- f. Actuator Requirements for SCADA:
 - 1) Butterfly valves are to be equipped with motorized actuators, suitable for the valve.
 - 2) Actuators shall be equipped with L-O-R selector, along with Open-Stop-Close pushbuttons.
 - 3) Actuators for V540 rectangular butterfly valve shall be equipped with a ProfiBus DP interface.
 - 4) Signals required over ProfiBus to/from SCADA include:
 - a) Valve in Remote (from L-O-R selector).
 - b) Valve Actuator Fault.
 - c) Command to Open Valve from SCADA.
 - d) Command to Close Valve from SCADA.
 - e) Valve Opened Status to SCADA.
 - f) Valve Closed Status to SCADA.
 - 5) In the event of a ProfiBus signal loss or an actuator fault, the valve shall stay in its current position, and not default to the full-open or full-closed position.
- 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.
 - e. 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.
- 4. Limit Switch:
 - a. 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.
- 5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
- 6. Manufacturers and Products:
 - a. Rotork Controls; IQ/IQT Series.
 - b. "Or-equal."

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, bearing valve tag number shown on Electric Actuated 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. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.
 - 1. Manufacturers:
 - a. Pratt.
 - b. DeZurik.
- D. Floor Stand:
 - 1. Nonrising, heavy pattern, indicating type.
 - 2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment. Stem length as required to connect valve operating nut and floor stand.
 - 3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
 - 4. Anchor Bolts: Type 304 stainless steel.
 - 5. Manufacturers and Products:
 - a. Clow; Figure F-5515.
 - b. Mueller, Figure A-26426.
- E. Chain Wheel and Guide:
 - 1. Handwheel direct-mount type.
 - 2. Complete with chain.
 - 3. Galvanized or cadmium-plated.
 - 4. Manufacturers and Products:
 - a. Clow Corp.; Figure F-5680.
 - b. Walworth Co.; Figure 804.
 - c. DeZurik Corp.; Series W or LWG.
- F. Indicator Post Assembly:
 - 1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
 - 2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
 - 3. Padlockable eye bolt for wrench.

4. Adjustable bury depth. Bury depth as required for valve installation.
5. UL listed and FM approved.
6. Manufacturers and Products:
 - a. Clow; Style 2945.
 - b. Mueller; A-20806.

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 according to 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.
3. Eccentric Plug Valves:
 - a. Unless otherwise restricted or shown on Drawings, install valve as follows:
 - 1) 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 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. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.
 - G. 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.
 - H. 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.
 - I. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

- J. 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. V405.
 - 2. V540.
- B. Manufacturer’s Representative: Present at Site for minimum person-days 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 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 supplement listed below, following “End of Section,” is part of this Specification.

1. Electric Actuated 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
BFV-110	V540	480-volt, three-phase	30"x120"	SW	24,306	5	M	30	C, D
BFV-210	V540	480-volt, three-phase	30"x120"	SW	24,306	5	M	30	C, D
BFV-310	V540	480-volt, three-phase	30"x120"	SW	24,306	5	M	30	C, D
BFV-410	V540	480-volt, three-phase	30"x120"	SW	24,306	5	M	30	C, D
BFV-111	V540	480-volt, three-phase	36"x72"	SW	24,306	5	M	30	C, D
BFV-211	V540	480-volt, three-phase	36"x72"	SW	24,306	5	M	30	C, D
BFV-311	V540	480-volt, three-phase	36"x72"	SW	24,306	5	M	30	C, D
BFV-411	V540	480-volt, three-phase	36"x72"	SW	24,306	5	M	30	C, D
PV-101	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-102	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-103	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-104	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-105	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-106	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-107	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-108	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-201	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-202	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-203	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-204	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-205	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-206	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-207	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-208	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D

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
PV-301	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-302	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-303	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-304	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-305	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-306	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-307	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-308	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-401	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-402	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-403	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-404	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-405	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-406	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-407	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
PV-408	V405	120-volt, single-phase	4"	SL	200	11	M	30	C, D
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 = See individual valve section for details.									

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 14 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. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
3. 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.
4. Test Pressure: As indicated on Piping Schedule.

- C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

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.

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Fill piping with potable water and let sit for 24 hours. Inspect pipelines and repair any leaks.
- B. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.04 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

SECTION 40 90 00
INSTRUMENTATION AND CONTROLS
SCOPE OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. This Specification provides details to the Contractor regarding the instrumentation and controls (I&C) control system scope, including requirements for procurement, fabrication, installation, wiring and startup. This Specification is for the North Jersey District Water Supply Commission (NJDWSC) at the F.A. Orecho Drive facility in Wanaque, New Jersey. The purpose of this Specification is to describe the control system upgrades, including instrumentation and network enhancements for this Project. The provided Drawings, documents and Specifications will be the basis for the Contractor's detailed design deliverables. Refer to network architecture diagrams I-010 and I-011 for an overview of the control systems.
- B. The Site has four existing basins that will undergo various I&C upgrades as part of the Project. Each basin has an upper and a lower section. New stick-built and vendor-provided panels shall be fabricated and connect to new networks. The termination point for all networks in scope is in the MCC room in the Chemical Building. Upgrades to network hardware will occur to allow the new network connections.

1.02 DESIGN BASIS SUMMARY

- A. Note that the manufacturer and model numbers listed reflect NJDWSC preferences. Substitutions to NJDWSC preferences may be considered.
- B. Sludge Valve Panels: Basin sludge valves are connected to new vendor-provided sludge control panels. The valves will communicate to their respective sludge panels via ProfiBus. This includes valve open/closed commands, position feedback, and other status and alarm information for as required by NJDWSC. There is one sludge control panel for every 4 valves. There are a total of 8 sludge panels, with a total of 32 valves. Each control panel has an Emerson (formerly GE) PAC Systems RX3i IC695 controller, power supply and ProfiBus master. Field input/output (I/O) that is not ProfiBus-related shall be connected to IC694 I/O modules. The I/O complement shall be sufficient for the application, plus 20 percent spare I/O capacity.
- C. Media Converter Panels: For each of the 8 sludge valve panels, a stick-built media converter panel is required. For each panel, the Contractor shall provide

a copper/fiber media converter, 120V ac/24V dc power supply, terminal strip and any required cabling in the panel.

- D. Flocculator Panels: Each of the 4 basins shall have a new vendor-provided flocculator control panel, each with a PLC and a set of four variable frequency drives (VFDs). Flocculator VFDs communicate to the PLC via ProfiNet. Each panel contains:
1. PLC: Emerson (formerly GE) PAC Systems RX3i IC695 controller, power supply, ProfiNet interface and network switches. Field I/O that is not ProfiNet-related shall be connected to IC694 I/O modules. This includes I/O required from each of the 4 VFDs per panel. The I/O complement shall be sufficient for the application, plus 20 percent spare I/O capacity.
 2. VFDs: For each flocculator panel, there will be 4 Emerson PACMotion VFDs with a ProfiNet interface. A network switch connects the 4 VFDs to a ProfiNet interface to the PLC. I/O from each VFD is wired to PLC I/O modules as required.
- E. Influent/Effluent Control Panels: All 4 basins share a common control panel for the influent/effluent valves, provided by the Contractor. The influent/effluent control panel has an Emerson (formerly GE) PAC Systems RX3i IC695 controller, power supply, ProfiBus master and a copper/fiber media converter. Field I/O that is not ProfiBus-related shall be connected to IC694 I/O modules. The I/O complement shall be sufficient for the application, plus 20 percent spare I/O capacity. The influent and effluent valves communicate to the PLC via ProfiBus. The flowmeters and turbidity meters are connected to IC694 I/O modules as isolated 4 mA to 20 mA signals.
- F. Networks (Refer to Drawings I-010 and I-011):
1. ProfiBus: Sludge, influent, and effluent valves are connected to their respective PLC panels via a ProfiBus interface.
 2. ProfiNet: Flocculator VFDs are connected to their respective PLCs via ProfiNet interface.
 3. Ethernet (Copper): Network cabling less than 100 meters will be routed via Category 6 Ethernet cables.
 4. Ethernet (Fiber): Network cabling greater than 100 meters will be routed via single-mode fiber cables.
- G. Definitions: The following describes the definitions of the Owner, the Contractor, the Systems Integrator and the Design Engineer.
1. Owner: North Jersey District Water Supply Commission (NJDWSC).
 2. Contractor: The firm or company that is awarded the contract for the Work. This includes the General Contractor and all relevant subcontractors, including Electrical and I&C. This also includes the

- Contractor for vendor-provided skids. The Contractor is also responsible for control system detailed design and panel fabrication of their respective control systems.
3. System Integrator (SI): The Owner (NJDWSC) shall perform systems integration work once the Contractor(s) install their respective control system and related instrumentation, and have fully tested their respective automated system prior to Owner's system integration work.
 4. Engineering Firm: Jacobs Engineering.
- H. If this Specification conflicts with any of the referenced documents or drawings, or with actual site conditions, the Contractor shall communicate the conflict or issue immediately to the Owner or its designee for resolution.
- I. This document does not discuss the electrical upgrades for this Project, including new or modified motor controls, conduit routing, or panel and equipment location plan Drawings. Refer to the relevant Electrical Specifications, Drawings, and documents for these details.

1.03 CODES, STANDARDS, AND PERMITS

- A. All work shall be performed, and materials shall be furnished in accordance with the following standards as applicable:
1. American National Standards Institute (ANSI).
 2. American Wire Gauge (AWG).
 3. ASTM International (ASTM).
 4. Federal, State, and Local Codes.
 5. FM Global (FM).
 6. Institute of Electrical and Electronics Engineers (IEEE).
 7. International Society of Automation (ISA).
 8. National Electrical Manufacturers Association (NEMA).
 9. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 10. North Jersey District Water Supply Commission (NJDWSC) Standards.
 11. UL.

1.04 INSPECTIONS

- A. If required, comply with requirements of any local inspection authority regarding any permits or Electrical inspections by the local utility.
1. Schedule inspections with the local inspection authority so that no new work is concealed prior to required inspections.
 2. Factory Acceptance Test (FAT): At the discretion of the Owner or its designee, fabricated panels may be subjected to inspection and testing prior to arrival at Site. The FAT may be a prerequisite for acceptance. The Contractor shall plan for personnel to arrive at the fabricator's

facility for the FAT. The Contractor shall also allow provisions for a Contractor's representative and a technician to assist in testing. Temporary power and networking should also be expected as part of the FAT procedure.

1.05 DRAWINGS AND DOCUMENTS

- A. The Contractor shall provide the following drawings in accordance with the P&ID information provided by Engineering:
 - 1. Detailed Panel Layout Drawings: Panels shall be fabricated according to these drawings.
 - 2. Control Power Distribution Drawings: Ac and dc control wiring.
 - 3. Schematic Drawings: I/O connections from panel to field.
 - 4. Refer to Section 40 95 13, Fabricated Control Panels for panel fabrication requirements.
 - 5. Network Architecture Diagrams: Details the ProfiBus, ProfiNet, copper and fiber network connections for the entire facility. Engineering shall provide a network architecture diagrams (I-010 and I-011) as a basis for further development in detailed design by the Contractor.
- B. Refer to the relevant Division 26, Electrical specifications and supporting Drawings for preliminary details regarding conduit routing. Actual conduit routings are to be field determined by the Contractor.
- C. Reference Documents and Drawings: The following I&C-related drawings and documents, along with this specification, form the basis of the I&C scope to be performed by the Contractor.
 - 1. Controls Architecture Network Diagrams I-010 (Basins 1 and 2) and I-011 (Basins 3 and 4).
 - 2. Section 40 90 00, Instrumentation and Controls Scope of Work (this document).
 - 3. Section 40 91 00, Instrumentation Devices.
 - 4. Section 40 95 13, Fabricated Control Panels.
 - 5. Section 40 95 73, Control Signal Wiring.

1.06 SUBMITTALS

- A. The Contractor shall submit for approval any required Contractor detailed design drawings and documents for all related deliverables as described in this specification, including instrumentation and devices, prior to fabrication or purchase.

B. Upon Project Completion, submit the following:

1. Supply "as-built" drawings from the drawing set provided: Marked-up red line drawings shall be provided to the Owner or its designee.
2. Give the Owner's representative all manufacturers' literature upon completion of job.

1.07 PROCEDURES

- A. Receive and inspect any instrumentation, components, junction boxes, and control panels. Notify the Owner immediately of any signs of damage or if discrepancies exist between the packing slip and the items being received.
- B. Maintain field records indicating date for receipt of instruments and control panels on-site.
- C. Store all instruments, control panels, and junction boxes in a clean and dry area that provides shelter from the rain and mechanical abuse. Provide heating/cooling to maintain a storage temperature between 40 degrees F and 80 degrees F.
- D. Ensure that all miscellaneous items such as special cabling, mounting brackets, etc., are stored with the associated instruments or control panels.
- E. Protect the instrument flange faces of flow meters from mechanical abuse.
- F. Furnish all materials required for the proper installation and to complete the installation to the satisfaction of the Owner.
- G. Perform field testing and provide adequate documentation, adjusting as necessary, to ensure proper performance of the I/O and final control elements provided as part of control system.
- H. Provide supervision and labor that has been qualified by training and experience, to perform the specific activities.
- I. Ensure that plugs and caps are not removed from instrument openings/connections during storage.

1.08 SEQUENCING/SCHEDULING

- A. It is the responsibility of the Contractor to sequence and schedule all Work. The Contractor will coordinate with all other disciplines and trades to schedule all Work. Any re-work caused by inadequate coordination with other trades or contractors will be the responsibility of the Contractor.

1.09 COORDINATION

- A. Inspections and Reports: Inspect the work of other contractors that precedes your work and upon which your work depends. Report to the Owner any deviations from the Contract Documents. Failure to make an inspection and report shall constitute an acceptance of the other contractors' work.
- B. Delays: Notify the Owner in advance of any existing or foreseeable causes for delay in the Work.

1.10 DRAWING CONFLICTS

- A. Lay out your work first, before you start, and report all drawing conflicts to the Owner. The Owner will not assume responsibility for cost incurred by the Contractor because of lack of preparation. Any discrepancies between drawings, documents, or specifications shall be brought to the attention of the Owner or its designee prior to commencement of Work.

1.11 SYSTEM INTEGRATION ACTIVITIES

- A. Provide and test a complete PLC program for PLC control panels in scope that meets the criteria of the connected devices. Vendor-provided PLC system integration shall be done by the respective vendor. Include fully documented program with references and I/O tag listing. System integration activities for stick-built panels shall be done by Owner.
- B. Configure all PLC hardware and network switches.
- C. Configure and test network connections. Fiber transmission rates shall be consistent and compatible with the network hardware.
- D. Set the required ProfiBus network transmission speed, anticipated to be 500 kbps or 1.5 Mbps. Confirm with Owner.
- E. Configure and test the VFDs, including all required parameters.
- F. Include SCADA graphic screens as required per the application and control system.
- G. Provide a fully functional, automated control system to the satisfaction of the Owner.
- H. The SI for vendor packaged systems shall design, fabricate and deliver the control panels. Deliverables include scaled, detailed panel layout drawings, and fully developed schematic drawings with bill of materials (BOM). The SI for vendor panels shall provide a complete and documented PLC program that has been tested prior to arrival at Owner's Site.

PART 2 PRODUCTS

2.01 CONTROL PANELS

A. Refer to Section 40 95 13, Fabricated Control Panels for fabrication details.

1. Sludge Panel SCP-01 (Vendor).
2. Sludge Panel SCP-02 (Vendor).
3. Sludge Panel SCP-03 (Vendor).
4. Sludge Panel SCP-04 (Vendor).
5. Sludge Panel SCP-05 (Vendor).
6. Sludge Panel SCP-06 (Vendor).
7. Sludge Panel SCP-07 (Vendor).
8. Sludge Panel SCP-08 (Vendor).
9. SCP-01 Media Converter Panel (Stick-built).
10. SCP-02 Media Converter Panel (Stick-built).
11. SCP-03 Media Converter Panel (Stick-built).
12. SCP-04 Media Converter Panel (Stick-built).
13. SCP-05 Media Converter Panel (Stick-built).
14. SCP-06 Media Converter Panel (Stick-built).
15. SCP-07 Media Converter Panel (Stick-built).
16. SCP-08 Media Converter Panel (Stick-built).
17. Basin 1 Flocculator Panel (Vendor).
18. Basin 2 Flocculator Panel (Vendor).
19. Basin 3 Flocculator Panel (Vendor).
20. Basin 4 Flocculator Panel (Vendor).
21. Basins 1 through 4 Influent/Effluent Panel (Stick-built).

2.02 NEW INSTRUMENTS

- A. Refer to Section 40 91 00, Instrumentation Devices for the requirements for new instruments that are required for the Project. The Contractor shall procure, store and install all new instruments that are not included with packaged skids. The skid vendor shall provide all instrumentation within the skid boundaries.
- B. All instruments provided shall include an instrumentation specification sheet, vendor cut sheets, and installation instructions. Refer to Section 40 91 00, Instrumentation Devices.

2.03 PANEL AND INSTRUMENTATION HARDWARE

- A. Contractor shall supply all required hardware for the mounting of panels, Contractor-provided instrument stands, field sensor mounting hardware, and any other related hardware as required.

2.04 JUNCTION AND PULL BOXES

- A. Contractor shall supply junction boxes and pull boxes as required to complete all required installations. Junction boxes shall have terminal strips as required and shall be labeled according to the drawings and documents.

2.05 NETWORK

- A. Provide all required network hardware and cabling for a complete installation, according to network controls architecture drawings I-010 and I-011. This includes but may not be limited to CAT 6 copper cables, single-mode fiber, ProfiNet and ProfiBus, with associated patch cables, fittings and connectors as required. The network shall be installed by a qualified network installer.

PART 3 EXECUTION

3.01 SCOPE EXECUTION

- A. General: The Contractor shall provide all required labor and materials to complete the project to the satisfaction of the Owner. The Contractor shall make use of the associated drawings and documents provided as the basis of the design for the I&C upgrades.
- B. Drawing List: The drawing package includes control panel layouts, control power distribution, I/O schematics, terminal block details, selected installation details, bill of materials, and nameplate schedules. The Contractor shall provide a complete drawing list. Drawing numbers shall be coordinated in accordance with the Owner's drawing numbering standards.
- C. AutoCAD 2019 shall be used to create the drawings as required.
- D. Use AutoCAD borders, title blocks, and drawing numbers as directed by NJDWSC or designee.
- E. FAT: The Owner (or its designee) may require inspections of panels or skids prior to shipment to the Site, and as a prerequisite to acceptance and turnover of ownership. The Contractor should anticipate and allow for a complete FAT. The FAT process shall include the inspections and testing methods as required by the Owner. As-built redlines or revised drawings shall be used as the basis of the FAT.

END OF SECTION

SECTION 40 91 00 INSTRUMENTATION DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. General This Specification pertains to the off-skid field instrumentation requirements for the North Jersey District Water Supply Commission (NJDWSC) at the F.A. Orecho Drive facility in Wanaque, New Jersey. In particular, this Specification provides instrumentation details for basin influent and effluent Site monitoring as described below.
- B. Basin Turbidity Monitoring (2.4):
 - 1. AE/AIT-111.
 - 2. AE/AIT-211.
 - 3. AE/AIT-311.
 - 4. AE/AIT-411.

1.02 MAKE/MODEL NUMBERS OF INSTRUMENTS

- A. Note that the instrument manufacturer and model number series as described in Part 2, Products are considered NJDWSC or Engineering preferences, and are listed as a design guide. Substitutions may be considered.

1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. Process Instrumentation Diagrams (PIDs):
 - a. Instrument tag identifier.
 - b. Line size.
 - c. Piping details and materials.
 - d. Process connections.
 - e. Process ranges.
 - f. Control system and supervisory control and data acquisition (SCADA) interfacing.
 - 2. Codes and Standards – as Applicable:
 - a. International Society of Automation (ISA).
 - b. Local and State Codes.
 - c. National Electrical Manufacturers Association (NEMA).
 - d. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - e. NJDWSC Standards.
 - f. UL.

1.04 SYSTEM DESCRIPTION

- A. This Specification consists of field instrumentation devices as noted in Part 2, Products.
- B. Scale all indicators in the specified engineering units unless otherwise indicated.
- C. The Contractor shall ensure that each instrument is provided with a permanently attached tag. Tags shall be 2-inch diameter round phenolic plastic, black on both sides with 5/16-inch engraved white lettering centered on the tag. Tag shall be attached to the instrument using stainless steel wire rope. Ferrules, if used, are to be stainless steel. In the event that the instrument manufacturer does not provide instrument tags meeting these requirements, the Contractor shall provide these tags.
- D. All instrument wiring shall include wire and cable labeling, identifying the instrument with the instrument tag number.
- E. Provide mounting hardware for sensors, transducers and meters as required.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.
 - 2. Indicate complete make and model of instruments that are to be submitted. Indicate any deviations from the preferred model numbers in this Specification.
- B. Informational Submittals:
 - 1. Provide the instrumentation cut sheets as applicable, including installation guidelines.
 - 2. Manufacturer's Certificate: Provide instrument certificates as applicable.
 - 3. Source Quality-control Submittals: Indicate results of factory tests and inspections.
 - 4. Submit product data information, data sheets, installation details and calibration reports as required. Retain all relevant documents for turnover to the Owner.

1.06 WARRANTY

- A. Refer to manufacturers' standard warranty. Retain all warranty information for turnover to the Owner.

1.07 QUALITY ASSURANCE

- A. Ensure that materials of construction of wetted parts are compatible with process liquid.
- B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.08 CALIBRATION

- A. Instrumentation shall be provided with calibration certificates per process ranges as indicated.
- B. Review and verify calibration certificates. If required, Contractor to calibrate or re-calibrate instruments as applicable.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store equipment according to manufacturer instructions.

1.10 PROTECTION

- A. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
- B. Provide additional protection according to manufacturer instructions.

PART 2 PRODUCTS

2.01 BASIN TURBIDITY MONITORING

- A. Description: Turbidity analyzer and sensor.
- B. Analyzer/Sensor:
 - 1. Manufacturer: Hach.
 - 2. Analyzer Model Series: SC200.
 - 3. Turbidity Sensor: Hach SOLITAX SC (immersion).
 - 4. Process Range: .2 NTU to 1.0 NTU.
 - 5. Sensor Range: .001 NTU to 4,000 NTU.
 - 6. Signal : 4 mA to 20 mA, twisted pair shielded cable.
 - 7. Power: 120V ac.
 - 8. Display: Integral display with function keys.
 - 9. Enclosure Rating: NEMA 4X, IP65.

10. Mounting: Contractor-provided instrument stand.
11. Process Fluid: Water.
12. Accuracy: Plus or minus 0.5 percent.
13. Sensor Cable: Specify standard 10-meter cable, integral to sensor.
14. Calibration Certificate: To be provided.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Requirements for installation examination.
- B. Verify that items provided by other sections of Work are ready to receive Work of this section.

3.02 INSTALLATION

- A. Coordinate location and orientation of flow meters and sensors with final equipment installations.
- B. Ensure that instruments are located to be easily accessible for maintenance.
- C. Install instruments in accordance with manufacturer's installation guidelines.

3.03 FIELD QUALITY CONTROL

- A. Testing:
 1. Test and calibrate instrument to demonstrate that it meets specified accuracy requirements.
 2. Comply with AWWA M6.
- B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this section for not less than one day on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- C. Equipment Acceptance:
 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 2. Make final adjustments to equipment under direction of manufacturer's representative.
- D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.04 DEMONSTRATION

- A. Section 01 77 00, Closeout Procedures: Requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

3.05 DOCUMENT CONTROL

- A. Retain all relevant documents for turnover to Owner.

END OF SECTION

SECTION 40 95 13
FABRICATED CONTROL PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. The purpose of this specification is to give adequate details and direction for the fabrication of control panels for the North Jersey District Water Supply Commission (NJDWSC) at the F.A. Orecho Drive facility, Wanaque, New Jersey. This includes stick-built and vendor-supplied panels.
- B. Definitions: The following describes the definitions of the Owner and the Contractor.
 - 1. Owner: North Jersey District Water Supply Commission (NJDWSC).
 - 2. Contractor: The firm or company that is awarded the contract for the panel fabrication work. This includes the General Contractor and all relevant subcontractors, including electrical and instrumentation and control (I&C). Fabricated control panels as part of a vendor-manufactured skid shall also be directed by this Specification, where applicable.
 - 3. System Integrator (SI): The chosen SI shall provide automation requirements as referenced in the Contract Documents and Drawings provided. The SI may also be involved in the panel fabrication process, according to the Owner's request.
 - 4. Design Engineer: Jacobs Engineering.
- C. The Contractor shall procure, furnish, fabricate, wire and terminate fabricated control panels and any other panels as described in Part 2, Products, Article Manufacturers of this Specification section.
- D. Reference Documents and Drawings: The following I&C-related drawings and documents, along with this specification, form the basis of the I&C scope to be performed by the Contractor.
 - 1. Controls Architecture Network Diagrams I-010 and I-011.
 - 2. Section 40 90 00, Instrumentation and Controls Scope of Work.
 - 3. Section 40 91 00, Instrumentation Devices.
 - 4. Section 40 95 13, Fabricated Control Panels (this document).
 - 5. Section 40 95 73, Control Signal Wiring.

1.02 SUBMITTALS

A. Action Submittals:

1. The Contractor shall furnish the following panel fabrication deliverables of the final panel designs for approval prior to fabrication, based on process and instrumentation diagrams (P&IDs) provided by Engineering.
 - a. Panel Exterior Layout Drawing(s): Dimensioned and scaled front panel layout of the panel showing details of enclosure, mounting hardware, signage, and any front panel-mounted instruments. The actual CAD drawing from the enclosure manufacturer should be used.
 - b. Panel Interior Layout Drawing(s): Dimensioned and scaled interior panel details, providing complete details of all components in the panel. When possible, panel components shall originate from scaled CAD drawings from the manufacturers that are used. Provide the complete BOM (bill of materials) with quantity, manufacturer and model number. Include item number references on BOM. Provide nameplate schedule, as all components and terminal strips shall require an identifier.
 - c. Control Power Distribution Drawing(s): Detailing 120V ac and 24V dc control wiring connections in the panel.
 - d. Schematic Drawings for Inputs/Outputs (I/O): Complete panel and field wiring connection details of all I/O points terminating in the panel.
 - e. Network Connection Detail Drawing(s): Inter-panel network connections.
 - f. Transfer to Owner or designee all catalog cut sheets, product data sheets, bulletins, or user manuals for all panel components,

- B. The Contractor shall submit final or redlined design detail drawings if there are any changes to the design provided after the design has been approved.

1.03 RECORD DRAWINGS

- A. Submit shop drawings as listed under Article Submittals above for approval of the Owner or its designee, and as a prerequisite for any planned factory acceptance testing (FAT).

1.04 CODES AND STANDARDS

- A. All panels shall be fabricated at a facility that is certified as UL 508A-compliant.

- B. All Work shall be performed, and materials shall be furnished in accordance with the following latest standards where applicable:
1. American National Standards Institute (ANSI).
 2. American Wire Gauge (AWG).
 3. ASTM International (ASTM).
 4. Federal, State, and Local Codes.
 5. FM Global (FM).
 6. Institute of Electrical and Electronics Engineers (IEEE).
 7. International Society of Automation (ISA).
 8. National Electrical Manufacturers Association (NEMA).
 9. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 10. North Jersey District Water Supply Commission (NJDWSC) Standards.
 11. UL.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Wrap completed panel(s) in polyethylene plastic and crate in a wooden shipping crate with sufficient packing to avoid damage in shipment.
- B. Support the base of shipping crate with cross members of sufficient strength and clearance to allow movement of entire crated panel by forklift truck.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Note that the manufacturer and model numbers listed reflect NJDWSC preferences. An “or-equal” offering may be considered.

2.02 BASIN INFLUENT/EFFLUENT CONTROL PANELS (STICK-BUILT)

- A. There is one common influent/effluent panel for basins 1 through 4. Contractor is to provide.
- B. Each panel has the following hardware:
1. NEMA 4X Enclosure: Allow for 20 percent spare panel space. This panel shall be located at the cattle chute.
 2. 120V ac/24V dc power supplies, 10 amps or 20 amps based on application. Include two power supplies and a redundancy module.
 3. Emerson RX3i CPU controller IC695CPE330.
 4. Emerson RX3i Power Supply, 120V A.C., 40 watts, IC695PSA040.
 5. Emerson RX3i ProfiBus Master Interface, IC695PBM300.
 6. Emerson RX3i IC694 I/O modules. Refer to P&IDs for I/O types. Allow for 20 percent spare I/O. I/O should be 24V dc unless it is not practical.

7. Emerson RX3i Chassis: Example of a 12-slot chassis is Emerson IC695CHS012. Size chassis for the required I/O, CPU, power supply, and communication interface. Provide four spare slots for future expansion.
8. Copper-to-fiber media converter.
9. Ac and dc distribution and field wiring terminal strips.
10. Panel shall be located outside. Provide adequate panel heating and cooling hardware.
11. Provide all required inter-panel wires and cables.

2.03 SLUDGE VALVE CONTROL PANELS (VENDOR-PROVIDED)

- A. There are a total of eight sludge valve control panels, two per basin. They are identified as SCP-01 through SCP-08.
- B. Each panel has the following hardware:
 1. NEMA 4X Enclosure: Allow for 20 percent spare panel space.
 2. 120V ac/24V dc power supplies, 10 amps or 20 amps based on application. Include two power supplies and a redundancy module.
 3. Emerson RX3i CPU controller IC695CPE330.
 4. Emerson RX3i power supply, 120V A.C., 40 watts, IC695PSA040.
 5. Emerson RX3i ProfiBus master interface, IC695PBM300.
 6. Emerson RX3i IC694 I/O modules. Refer to P&IDs for I/O types. Allow for 20 percent spare I/O. I/O should be 24V dc unless it is not practical.
 7. Emerson RX3i Chassis: Example of a 12-slot chassis is Emerson IC695CHS012. Size chassis for the required I/O, CPU, power supply, and communication interface. Provide four spare slots for future expansion.
 8. Copper network switch.
 9. A.C. and D.C. distribution and field wiring terminal strips.
 10. Panel shall be located outside. Provide adequate panel heating and cooling hardware.
 11. All required inter-panel wires and cables.
 12. Other panel hardware not listed typically provided by the selected vendor.
 13. Provide a power source for the corresponding media converter panel as described in Article Copper-fiber Media Converter Panels (Stick-built).

2.04 COPPER-FIBER MEDIA CONVERTER PANELS (STICK-BUILT)

- A. There are a total of eight media converter panels, two per basin. Each panel shall be located near or attached to the corresponding SCP panel as described in Article Sludge Valve Control Panels (Vendor-provided). Contractor is to provide.

- B. Each panel has the following hardware:
1. NEMA 4X enclosure.
 2. Copper-fiber media converter.
 3. Terminal strip for converter power source (from associated SCP panel).
 4. Panel shall be located outside. Provide adequate panel heating and cooling hardware.
 5. All required inter-panel wires and cables.

2.05 FLOCCULATOR CONTROL PANELS (VENDOR-PROVIDED)

- A. There are a total of four flocculator control panels, one for each basin.
- B. Each panel has the following hardware:
1. NEMA 4X Enclosure: Allow for 20 percent spare panel space.
 2. Four variable frequency drives (VFDs), each equipped with a ProfiNet interface module.
 3. 120V ac/24V dc power supplies, 10 amps or 20 amps based on application. Include two power supplies and a redundancy module.
 4. Emerson RX3i CPU controller IC695CPE330.
 5. Emerson RX3i power supply, 120V A.C., 40 watts, IC695PSA040.
 6. Emerson RX3i ProfiNet interface module (for VFD communications).
 7. Emerson RX3i IC694 I/O modules. Refer to P&IDs for I/O types. Allow for 20 percent spare I/O. I/O should be 24V dc unless it is not practical.
 8. Emerson RX3i Chassis: Example of a 12-slot chassis is Emerson IC695CHS012. Size chassis for the required I/O, CPU, power supply, and communication interface. Provide four spare slots for future expansion.
 9. Network switch for the ProfiNet connections from each VFD.
 10. Copper-fiber media converter.
 11. Ac and dc distribution and field wiring terminal strips.
 12. All required inter-panel wires and cables. Includes patch cables.
 13. Other panel hardware not listed typically provided by the selected vendor.

2.06 OTHER NETWORK HARDWARE

- A. Contractor to provide all required network hardware in accordance with drawings I-010 and I-011. In particular, include copper-fiber media converters required for the SCADA network hardware, located at the MCC room in the Chemical Building.

2.07 ENCLOSURES AND COMPONENTS

- A. The panel fabricator shall procure, fabricate, wire and label all control panels in accordance with the BOM (bill of materials) of the corresponding panel

layout drawings and associated schematics provided by the Contractor for stick-built panels, according to approved shop drawings. Panels provided by a vendor shall be fabricated according to approved shop drawings.

- B. Panel enclosures shall be provided according to manufacturer and model number indicated on the BOM located on the panel layout drawings.
- C. After approval of the panel design, panel hardware or component substitutions are not permitted without the approval of the Owner or its designee.
- D. Provide panel nameplates, both exterior and interior, in accordance with nameplate schedules on panel layout drawings. Unless otherwise indicated, nameplates shall be phenolic, with a white outer surface and a black inner core for engraved text. Nameplate adhesive shall be industrial-rated, to withstand outside weather conditions. Use outdoor-rated glue if nameplate adhesive is not sufficient. All nameplates shall be beveled. Outer panel nameplates shall be 3 inches by 6 inches with 3/4-inch lettering. Interior nameplates shall be 3/4 inch in height, with 3/8-inch lettering. Width of interior nameplates can be as small as 1 inch, and up to 2 inches, depending on text.
- E. Provide wire or cable labeling in accordance with control power distribution and schematic drawings. Labels will be the heat-shrink type, printed and not hand-written. Contractor shall ensure that all cable or wire labels can be easily readable and are the proper orientation. Wire and cable labels shall not be installed in wireways or otherwise hidden from view. All wires and cables shall have a corresponding label.
- F. All terminal blocks shall be labeled in accordance with control power distribution and schematics. Refer to the BOM on the panel layout drawings. Terminal block labels shall be printed, and not hand-written. The Contractor may substitute other types of printed terminal block labels with the approval of the Owner or its designee.
- G. Signage: Control panels shall all required signage relating to short circuit current rating (SCCR), and incoming power sources, and other signage as required. All panels shall have arc flash rating signage and personal protective equipment (PPE) requirements as a result. Arc flash labeling is typically done once the panel is installed at Site and incoming fault currents are established.
- H. 120V ac shall be the highest voltage allowable in a control panel. Voltages higher than 120V ac should be provided by a separate power panel.
- I. Provide UL 489-rated circuit breakers for the 120V ac main incoming feed and all 120V ac branch feeds.
- J. Provide 24V dc fusible terminals for all 24V dc branch feeds. Fuse terminals shall include fuse-blown indicators.

- K. Include a circuit breaker and fuse chart inside each panel. Chart shall be laminated or otherwise protected. Indicate circuit breaker and fuse I.D., amp rating, and fuse size and type. Use slow-blow fuses where applicable.
- L. Supply 5 spare fuses of each type per panel as spares.
- M. Contractor shall provide to Owner or designee a suggested and combined spare parts list.
- N. Contractor shall include all necessary and required signage, including potential arc flash labeling and SSCR.
- O. Provide copper ground bus bars in the rear of the panel. All bus bars shall be bonded together. Ground bus shall be capable of accepting system ground grid connection and power system ground connection. Provide grounding straps from enclosure to panel door. All ground connections shall test at less than 1-ohm resistance.
- P. Designed provision is for 20 percent spare, contiguous panel/sub-panel mounting area to accommodate future panel expansion. Contractor to fabricate according to the provided panel layout drawings.
- Q. The Contractor shall investigate the space allocated for control panels on the accompanying Drawings and inform the Owner of any potential problems.
- R. There shall be a complete separation of ac and dc wiring and cabling in the panel design, including wireways and conduits. Ac and dc can only cross at 90-degree angles.
- S. All Drawing notes shall be incorporated into control panel fabrication.
- T. Use earth and shield ground in accordance with manufacturer's guidelines.

2.08 WIRING

- A. Refer to Section 40 95 73, Control Signal Wiring for details on wire and cable types, color codes and other specifics.
- B. Mark all wires with approved wire markers at all terminations. Clearly mark all terminal blocks. Label all devices mounted on the steel sub-panel. All I&C devices located inside control panels shall have an engraved phenolic nametag affixed on or near the device and shall bear the tag number and service description. Label all devices mounted on the panel front with engraved phenolic nameplates. Nameplates shall be 3-layer laminated plastic; black letters on a white background. Letter height to be 1/8-inch for individual devices and 1/4-inch for panel designation. Exterior nameplates for outdoor panels shall be reversed-engraved.

- C. Neatly bundle and secure all wiring with plastic ties. Route back-of-panel wiring in slotted plastic wireways with snap-on covers.
- D. Ac and dc wiring shall not be routed in parallel in any wireway but may cross at a 90-degree angle.

PART 3 EXECUTION

3.01 IN-SHOP TESTING

- A. Thoroughly shop-test the completed panel or assembly.
 - 1. Ensure that all wires and cables are securely connected.
 - 2. Ensure all labels and nameplates are easily readable.
 - 3. Perform 100 percent continuity checks.
 - 4. Provide a temporary power source (120V ac), and check voltage on all applicable circuits. This includes any 24V dc power supplies.
 - 5. Provide documents and drawings of the completed testing procedures.
 - 6. Complete the fabrication and testing to the satisfaction of the Owner or its designee.
- B. Housekeeping: Remove all debris, metal shavings, wire insulation and other foreign objects from panel once the fabrication has been completed.
- C. Any temporary protective film meant to protect sensitive electronic hardware should be left intact, if it does not interfere with testing or functionality.
- D. Notify the Owner or its designee of any outstanding issues as a result of the testing procedures, particularly any which may have a scheduling impact. Resolve any internal punchlist items.
- E. Power-up and configure all devices that have IP addresses, as applicable. Set any dip switches or rotary switches as required.

3.02 FACTORY ACCEPTANCE TESTING (FAT)

- A. The Owner may elect to have control panels inspected prior to delivery to Site. The Contractor shall anticipate and allow for a visit by the Owner its designee for a FAT if required, once the panel or assembly has been tested in accordance with Article In-Shop Testing.
- B. The Contractor shall provide (typically highlighted) as-fabricated drawings, verification of the BOM, wiring connection checks, continuity checks, and powered checks.
- C. A punchlist shall be generated by the FAT personnel for any modifications needed prior to shipment to the Owner's facility. Successful completion of the

FAT is typically a prerequisite for delivery to the Owner's facility. All FAT punchlist items shall be recorded and resolved.

- D. Upon completion of the FAT, revise all drawings and documents as applicable, and provide record drawings as described in Article Record Drawings.

3.03 DRAWING STANDARDS AND DEVELOPMENT

- A. AutoCad 2019 shall be used for all panel drawing deliverables as described Article Submittals. Defer to the Owner (or designee) for the applicable CAD drawing standards that are to be used.
- B. Use the Owner's title block and border details as required, unless exempted by the Owner.
- C. Refer to Owner (or designee) the drawing numbers that are to be used. Allocation of drawing numbers shall be considered prior to finalized design for approval.

3.04 SYSTEMS INTEGRATOR RESPONSIBILITIES

- A. Refer to Section 40 90 00, Instrumentation and Controls Scope of Work, Article Systems Integrator Responsibilities, for additional details regarding the roles and responsibilities of the SI.

END OF SECTION

SECTION 40 95 73
CONTROL SIGNAL WIRING

PART 1 GENERAL

1.01 SUMMARY

- A. The purpose of this Specification is to provide details of control wiring requirements to the Contractor regarding panel and field control and network wire and cabling, for the North Jersey District Water Supply Commission (NJDWSC) Clarifier Rehabilitation, Basins 1-4 Project in Wanaque, New Jersey.
- B. Contractor shall provide, route, install, wire, label, and terminate all wiring as indicated on the Drawings and Contract Documents. Provide all fittings, connectors, and other hardware to complete the wiring installation to the satisfaction of the Owner.
- C. Panel Wiring: The Contractor shall provide, install, label, and terminate all panel wiring in accordance with panel layout drawings, control distribution drawings, and schematics produced for the Project. This includes ac and dc control power circuits, input/output (I/O) wiring, and network cabling.
- D. Field Wiring: The Contractor shall provide, install, label and terminate all field wiring per the panel layout drawings, control distribution drawings and schematics produced for the project. This includes ac and dc control power circuits, I/O wiring, and network cabling.
- E. Contractor is to determine conduit and cable routing between the programmable logic controller (PLC) panels (stick-built), vendor-provided skid panels, network hardware, instruments and other components requiring control signal, and power field wiring. Refer to the provided documents and I&C and Electrical Drawings.
- F. Types of wires and cables per types of devices and I/O shall be detailed in Part 2, Products.
- G. This section only discusses control signal wiring and cabling. Although the highest voltage in control panels is typically 120V ac, variable frequency drive (VFD) panels contain 480V ac. Panels with higher voltages require additional personal protective equipment (PPE) to protect against potential arc flash. For information on other voltages, or for details of VFD or motor loads of any voltage, refer to relevant Division 26, Electrical Specifications.

1.02 DEFINITIONS

- A. The following describes definitions of the Owner (or County) and the Contractor:
 - 1. Owner: North Jersey District Water Supply Commission (NJDWSC).
 - 2. Contractor: The firm or company that is awarded the contract for the Work. This includes the General Contractor and all relevant subcontractors, including electrical and instrumentation and control (I&C).

1.03 CODES AND STANDARDS

- A. All panels shall be wired at a facility that is UL-certified, meaning that all components shall be UL listed or UL-recognized.
- B. All Work shall be performed, and materials shall be furnished in accordance with the following latest standards where applicable:
 - 1. American National Standards Institute (ANSI).
 - 2. American Wire Gauge (AWG).
 - 3. ASTM International (ASTM).
 - 4. Federal, State, and Local Codes.
 - 5. FM Global (FM).
 - 6. Institute of Electrical and Electronics Engineers (IEEE).
 - 7. International Society of Automation (ISA).
 - 8. National Electrical Manufacturers Association (NEMA).
 - 9. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - 10. North Jersey District Water Supply Commission (NJDWSC) Standards.
 - 11. UL.

1.04 RELATED REFERENCE DOCUMENTS

- A. Specifications: The following I&C Specifications form part of the basis of design.
 - 1. Section 40 90 00, Instrumentation and Controls Scope of Work.
 - 2. Section 40 91 00, Instrumentation Devices.
 - 3. Section 40 95 13, Fabricated Control Panels.
 - 4. Section 40 95 73, Control Signal Wiring (this document).
- B. I&C Drawing References:
 - 1. Network Architecture Diagrams:
 - a. Drawing I-010 – Network Architecture Diagram – Basins 1 and 2.
 - b. Drawing I-011 – Network Architecture Diagram – Basins 3 and 4.

- C. Division 26, Electrical References: Refer to relevant Division 26, Electrical Specifications and supporting Drawings for details regarding conduit routing, VFDs, power connections, and other Electrical requirements. These are not covered in the Division 40, Process Interconnections Specifications.

PART 2 PRODUCTS

2.01 AC WIRING (120V AC)

- A. Typical Applications: PLC panels, vendor-supplied skid panels, instruments and components requiring 120V ac power.
- B. Color Codes:
 - 1. Black: Ac hot or line (stranded).
 - 2. White: Ac neutral (stranded).
 - 3. Green: Ground (solid or stranded). Can also be green with yellow stripe.
 - 4. Red: Ac control wiring, I/O devices, ac relays, ac wiring for seal leak detectors, horn, beacon, etc. (stranded).
 - 5. Yellow: 120V ac power sources that stay energized and originate from a separate panel's power source.
- C. Insulation:
 - 1. Wires (Individual Conductors): MTW, THHN.
 - 2. Cables: Polyvinyl chloride (PVC) jacket (for multi-conductors), neoprene jacket (SJO cords), or in accordance with code requirements.
- D. Interior Panel Wiring:
 - 1. Ac incoming and branch circuit loads shall be protected by UL 1489 "C" curve circuit breakers and shall be provided in the panel designs.
 - 2. Wire sizing is based on AWG standards. For ac power wiring, 16 AWG is the minimum size allowable, regardless of feeder size or load. Feeders shall be sized based on breaker and load sizing according to application. NFPA 70, National Electrical Code (NEC) 2020 requirements for wire sizes shall apply. 12 AWG is used for incoming 120V ac for the PLC panel and remote input/output (RIO) panels, corresponding to the 20-amp circuit breaker in the panel.
 - 3. Keep ac wiring separated from dc or signal wiring in control panels, by routing ac circuits in separate wireways from dc circuits.
 - 4. Ac power wiring in panels shall be single conductor wires.

E. Field Wiring:

1. 120V ac field wiring shall not be installed in conduits with dc wiring, CAT 6 Ethernet cables, or 480V power wiring.
2. Multi-conductor cords are permissible as long as they comply with relevant Electrical codes and are approved for underground use. They also must have the required color-coding.

2.02 DC WIRING

A. Only 24V dc is discussed in this section, which is the only voltage required for D.C. power to components, I/O, instrumentation and other similar devices. Other D.C. voltages are not considered. If A.C. I/O is to be implemented, refer to Article AC Wiring (120V ac), paragraph Color Codes.

B. Color Codes:

1. Dark Blue: 24V dc positive (+), stranded.
2. Dark Blue with White Stripe: Dc common (COM) or 0-volt reference (stranded).
3. Green: Ground (stranded or solid). Can also be green with yellow stripe.

C. Insulation:

1. Wires (Individual Conductors): MTW, THHN.
2. Cables: PVC (multi-conductors).

D. Interior Panel Wiring:

1. Dc branch circuit loads shall be protected by fusible terminal blocks with fuse-blown indication. Use fast-acting or slow-blow fuses, based on the application. 5 mm by 20 mm and 1/4-inch by 1-1/4-inch fuses are typical.
2. Wire sizing is based on AWG standards. For dc wiring, 18 AWG is the minimum size allowable, regardless of feeder size or load. Feeders shall be sized based on fusing and load sizing according to the application, and taking into account any voltage drop calculations. NEC 2020 requirements for wire sizes shall apply.
3. Terminals connected to D.C. wiring shall be sized appropriately to accommodate the proper wire size. Trimming of stranded wire in order to get the wire to fit in the terminal block is not allowable.
4. Inter-panel dc power distribution wiring shall be single conductors only.

E. Field Wiring:

1. For dc field wiring, multi-conductor cables may be used provided that they meet code requirements and are a minimum 18 AWG size per

- conductor. For individual runs, a 2-conductor cable may suffice.
Voltage drop calculations shall be considered in wire sizing.
2. Color-coding requirements in accordance with paragraph Color Codes above shall be maintained for field wiring.
 3. Dc cables can only be routed in conduits with other dc or analog signal cables. Routing with ac cables is not allowed.

2.03 ANALOG SIGNAL CABLES

- A. Cables for 4 mA to 20 mA transmitters and other analog signals shall use a twisted-pair shielded cable, part number 8760 Belden, "or-equal." Cable is sized AWG 18. Color codes are as follows:
 1. Black: Positive (+).
 2. Clear: Common or Return (-).
 3. Shield: Shield wire.
- B. For shield (drain) wires, cut and trim the shields at the instrument, and land the shield wires on ground terminals in the respective panels.

2.04 COPPER ETHERNET CABLES

- A. Network Connections:
 1. For copper network connections, use Category 6 (CAT 6).
 2. Contractor shall provide RJ45 connectors and related hardware for installation.
 3. Copper Ethernet cables shall not be routed with ac cables.
 4. If connecting to VFDs or routing near motor loads, use shielded CAT 6.

2.05 FIBER CABLES

- A. Specifications:
 1. Single-mode fiber cable OS1/OS2. Number of strands dependent on the application.
 2. Wavelength of fiber and connected hardware is 1,310 nanometers (nm).
 3. Transmission rate for fiber and connected hardware is 100 Mbps, or in accordance with NJDWSC standards.
- B. Application:
 1. Installation, termination and routing of fiber cables shall be performed by a qualified installer. Install according to industry standard guidelines.
 2. Contractor shall provide all necessary fiber connectors (LC/SC/ST) and patch cables as required for installation.

3. Be mindful of the bending radius for fiber cables. For 90-degree or 270-degree bends, typically a pull box is used as fiber is looped in a wide radius to achieve 90-degree or 270-degree turns.
4. Ensure that network hardware, such as a copper-fiber media converter, is compatible with fiber cable type, wavelength, and transmission rates.

2.06 PROFIBUS

A. Specifications:

1. ProfiBus is used for valve actuators that will have a ProfiBus interface.
2. Use Belden 3079A. Substitutions are permitted with NJDWSC or designee consent.
3. Contractor shall provide all required ProfiBus connectors as required.
4. Provide termination resistors for each ProfiBus segment.
5. Install ProfiBus in accordance with industry standard guidelines.

2.07 PROFINET

A. Specifications:

1. ProfiNet is used for the flocculator VFDs.
2. Use CAT 6 copper Ethernet cables. Refer to Article Copper Ethernet Cables.
3. Contractor shall provide all connectors as required.
4. Install ProfiNet in accordance with industry standard guidelines.

2.08 WIRE AND CABLE LABELING

- A. All wires and cables, both field wiring and panel wiring shall be labeled in accordance with the Drawings. All Drawings shall include cable identifiers and individual wiring identifiers.
- B. Wire and cable labels shall be of the heat-shrink type. These shall be printed using permanent ink. Refer to the control panel and schematic Drawings for wire and cable identifiers.
- C. Orientation of the wire/cable labels shall be such that the labels are easily visible, regardless if installed in panels, instruments or in the field. Labels shall not be obstructed by wireways or other devices.

2.09 INSTRUMENTATION AND DEVICE TAGGING

- A. All field instruments shall be identified with an instrument tag. Instrument tag requirements are described in this section (signal wiring).
- B. Mounted instrument tag shall match the instrument tags listed as found on the P&IDs.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Thoroughly shop-test completed panel or assembly.
 - 1. Ensure that all wires and cables are securely connected to terminals,
 - 2. Ensure all labels are easily readable and match corresponding Drawings or schematics.
 - 3. Perform 100 percent continuity checks on all wires and cables.
 - 4. Use of ferrules, ring, or fork wire connectors shall not be allowed.

3.02 FACTORY ACCEPTANCE TESTING (FAT) AND SITE TESTING

- A. The Owner may elect to have control panels inspected prior to delivery to Site. The Contractor shall anticipate and allow for a visit by the Owner or its designee for FAT if required, once the panel or assembly has been tested in accordance with Article In-shop Testing of Section 40 95 13, Fabricated Control Panels.

3.03 SYSTEM INTEGRATION ACTIVITIES

- A. Refer to Section 40 90 00, Instrumentation and Controls Scope of Work, Article System Integration Activities, for additional details regarding the roles and responsibilities of the systems integrator.

END OF SECTION

SECTION 44 42 24.05
HOSELESS CABLE VAC SLUDGE COLLECTORS

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): 11, Load Ratings and Fatigue Life for Roller Bearings.
2. American Gear Manufacturers Association (AGMA).
3. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A48/A48M, Standard Specification for Gray Iron Castings.
 - c. D570, Standard Test Method for Water Absorption in Plastics.
 - d. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. MG 1, Motors and Generators.
5. UL: 674, UL Standard for Safety Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN

- A. The hoseless cable vac sludge collector system shall be installed in the sedimentation basins as shown on the Contract Drawings.
1. Sludge collector shall remove settled solids from the basin floor by means of differential head. Solids shall be discharged from the collector mechanism through a sludge exit pipe provided by the manufacturer.
 2. Any piping required to connect the sludge exit pipe and existing sludge piping shall be provided by the Contractor. Submit piping in accordance with Section 40 27 00, Process Piping—General.
 3. Flexible hoses or articulating pipes shall not be used for sludge removal.
- B. A single manufacturer shall provide all necessary equipment, controls, and appurtenances for a complete working system whether or not items are shown on the Drawings or specified.
- C. The Contractor shall field verify basin dimensions, obstructions, and installation requirements. This information shall be conveyed to the manufacturer before preparation and submittal of shop drawings.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Basin design and layout of equipment indicating all dimensions.
 - b. Head loss calculation through the sludge collector at design flow.
 - c. List of spare parts which could be purchased and kept on hand.
 - d. Complete submittal drawings of all equipment furnished.
 - e. Connection locations and support attachment details.
 - f. Certification for compliance to NSF/ANSI 61.
 - g. Make, model, weight, and horsepower of each equipment assembly.
 - h. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
 - i. 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, and weights of equipment associated therewith.
 - j. Cable load capacities.
 - k. Power wiring diagrams, including terminals and numbers.
 - l. Painting Systems: Include manufacturer's descriptive technical catalog literature and specifications.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Written verification of manufacturer's acceptance of concrete tank tolerances.
3. Manufacturer's warranty.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

- A. Provide equipment manufactured in a UL-certified facility as defined by UL and provide documentation of registration in shop drawings.
- B. Manufacture all components in a fabrication facility producing only stainless-steel equipment. Due to potential for cross contamination, facilities that produce or handle both stainless and carbon steel materials will not be accepted.

- C. All hoseless sludge collector manufacturers must have at least 50 hoseless sludge collector installations. Installations shall have been in operation for at least 5 years, be of a similar length and design complying with these Specifications for use in municipal potable water applications as described above.

1.05 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

<u>Item</u>	<u>Quantity</u>
Shear pins for cable drive	2
8-inch polyurethane v-groove pulley	1
UHMW Delrin wheel bushings	12

- B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.06 SPARE PARTS

- A. At a minimum, provide the following spare parts:

1. Two shear pins for the cable drive.
2. One 8-inch polyurethane v-groove pulley.
3. Twelve UHMW Delrin wheel bushings.

1.07 WARRANTY

- A. Provide manufacturer's warranty as specified in these Contract Documents.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. Meurer Research, Inc.
 2. "Or-equal."

2.02 PROCESS DESIGN AND CONDITIONS

A. Number of Basins: Four.

B. Basin Description:

Basin Level:	Upper	Lower
Basin dimensions	144.5-foot L by 66-foot W	226-foot L by 66-foot W
Collector dimensions, each	Varies – see Drawings	Varies – see Drawings
Number of units per basin	4	4
Sludge flow per unit	150 to 200 gpm	150 to 200 gpm
Solids removal concentration	0.5 to 2.0 percent	0.5 to 2.0 percent

2.03 MATERIALS OF CONSTRUCTION

A. All major sludge collector components shall be fabricated of stainless steel materials except as noted.

1. Cross Bracing: ASTM A240, AISI Type 304.
2. Header Assembly and Pipe: AISI Type 304.
3. Bushings, Flow Balancing Ring and Tangential Orifices: UHMW-PE.
4. Cable Pulleys, Collector Pipe Supports and Wall Casters: Polyurethane.
5. Bolts, Nuts, Fasteners: IFI-104 Grade 304.

B. All fabricated stainless steel components shall be properly cleaned to prevent future corrosion. All welds shall be passivated by mechanical cleaning in accordance with ASTM A380. Nitric acid or other hazardous chemicals shall not be allowed for cleaning. Non-welded parts shall be supplied with standard mill finish.

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 that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI-61.

1. Use or reuse of components and materials without a traceable certification is prohibited.
2. Sludge collectors shall be certified by NSF to ANSI Standard 61. Systems that do not have stamped NSF 61 certification for the collectors as specified in the manufacturers name will not be accepted. Other agencies or certificates will not be allowed.

2.04 SHARED REEL DRIVE ASSEMBLY

- A. Each drive assembly shall consist of an SEW Eurodrive 3-phase 480V ac 1/4 hp inverter duty motor and SEW Eurodrive gearbox that shall be coupled to a single rotating drum for manipulation of the cable that is attached to the tandem suction header assembly. Food-grade lubricant shall be included. DC drives are not acceptable.
- B. The variable frequency drive (VFD) shall be an Allen-Bradley; Power Flex 525, or an equivalent type. VFD shall be fully able to integrate with the PLC control system hardware and SCADA system.
- C. Only single-drum drives are acceptable. Two or more cable drums are not allowed due to the high fleet angle created between drum and floor pulley.
- D. Cable shall be firmly attached to the rotating drum to prevent slippage. Tensioning the cable between multiple pulleys or use of a cable tensioning device to prevent slippage will not be allowed.
- E. Cable shall store on the reel in a single layer, the placement of which shall be organized by the drive mechanism. To minimize cable travel and the fleet angle, the cables shall share the same space on a single drum.
- F. Complete drive mechanism shall be packaged on a single powder-coated stainless steel base.
- G. A two-piece powder-coated aluminum safety cover with handles for ease of handling shall be supplied, requiring complete coverage of both reel and drive assembly. Covers made of fiberglass, steel, or stainless steel will not be allowed due to excessive weight during maintenance.
- H. Drive cable shall be Type 304 stainless steel with a minimum diameter of 1/4 inch. Collectors over 75 feet in length shall use pre-stretched cable. Pneumatic or steel tape drive systems are not acceptable.
- I. Drive assembly shall be capable of ceasing operation on an excessive load without physical damage to the drive unit. During an overload, protection built into VFD will cease operation and activate an alarm. Operation will continue after alarm is reset. Backup protection in the form of a shear pin is required.
- J. Drive assembly shall have integral position sensors that determine when the collector is at the end of the basin or the beginning of the basin. No underwater position sensors shall be required or allowed.
- K. Drive shall have an emergency disconnect button pre-wired to a junction box assembly, which shall be a large, red, palm-operated single button.

- L. For outdoor installations subject to extended freezing conditions, the drive assembly shall include a thermostatically controlled drum heater to prevent icing. The drum heater shall be powered from the collector control panel.

2.05 HOSELESS COLLECTOR ASSEMBLY

- A. Sludge collector assembly shall be manufactured entirely of Type 304 stainless steel, except for non-metallic parts such as casters, bushings, orifices, etc. which will be manufactured of non-metallic materials.
- B. Each collector assembly shall consist of four sludge collection header pipes each equal to half the basin width. Each header pipe shall have helical flow orifice blocks of UHMW-PE material spaced by the manufacturer to ensure proper distribution across the length of the header. Header pipes shall have removable end caps for easy cleanout.
- C. Header pipes shall be 3-inch diameter attached to the collection chamber by means of a flanged connection. Use of clamps or other pipe connection methods will not be allowed.
- D. Helical flow orifice blocks shall be designed to cause flow to enter tangentially into the header pipe for more-efficient sludge removal and reduced head loss. Orifices shall be 3/4 inch in diameter shaped to cause a spiral flow inside the header pipe to prevent solids from settling and shall point forward to remove settled solids ahead of the pipe as it travels down the basin. Holes drilled in the bottom of the header pipe shall not be allowed. Systems without forward facing replaceable tangential flow orifice blocks of UHMW-PE will not be allowed.
- E. The 6-inch collection chamber shall “telescope” over the smaller 4-inch fixed sludge-exit conduit. Articulating pipes, flexible sludge hoses, flexible hose joints, or swivel joints are not allowed.
- F. Collection chamber shall be isolated against the horizontal sludge-exit conduit by means of a UHMW-PE bushing. The bushing shall be designed to pass small amounts of water to act as a lubricant during operation. A fully sealed connection between the two pipes is prone to binding and not acceptable.
- G. Sludge-exit conduit shall include a UHMW-PE flow-balancing ring designed by CFD analysis to assure equal flow from the front and back sludge collection headers. Systems without a flow-balancing ring will not be allowed. Lateral piping or flow diagonals from sludge headers to the collection chamber shall not be an acceptable alternative to the flow-balancing ring.
- H. Each header pipe shall be equipped with a blade that is triangular and is roughly equal in length to the header pipe. These blades will move settled solids away from the end walls.

- I. Hoseless collector assembly shall be guided along basin length by means of horizontal casters on the ends of the header pipes.
- J. Flow through the hoseless sludge collector shall be controlled by a sludge valve as directed by the collector control panel. Submerged pump systems shall not be acceptable. Pumps (if used), valves, local disconnects, power, and actuator with position limit switches shall be provided by others under separate specification section(s).
- K. Each hoseless collector shall be complete with polyurethane rolling casters to support the collector assembly and horizontal side-wall casters located near the end of each of the four sludge collector headers. Use of anti-rocking skids in lieu of casters is not acceptable. Include all necessary mounting hardware.
- L. Concrete curbs with a minimum 6-inch vertical profile shall be provided by the Contractor as required between multiple units. Material vendor can also provide stainless steel curbing that allows for manual hose cleaning under and between installed curbing if concrete curbing is not appropriate.
- M. Include stainless steel end stops to be anchored to the basin floor at the header assembly's end of travel.
- N. All shop and field welds shall be performed by qualified welders in accordance with AWS D1.6. All seal welds shall be continuous, and all welds shall be mechanically cleaned in accordance with ASTM A380. Any field-welding of pipe to complete the assembly shall include use of a pickling paste.
- O. All underwater bearings shall be specifically designed for underwater use.

2.06 CONTROL SYSTEM

- A. There shall be eight collector control panels each designed to operate four hoseless sludge collectors. Control panels shall communicate to supervisory control and data acquisition (SCADA) via Ethernet communication. All eight panels are anticipated to be identical regarding the control panel hardware.
- B. Sludge valves shall be supplied and powered locally by others and controlled from the collector control panel.
- C. Collector Control Panel:
 - 1. Refer to I&C Specifications Section 40 90 00, Instrumentation and Controls Scope of Work and Section 40 95 13, Fabricated Control Panels, Article Sludge Valve Control Panels (Vendor-provided) for specifics regarding sludge collector control system requirements.
 - 2. Each control panel shall arrive to the jobsite internally pre-wired, ready to be installed.

- 3. Each control panel is powered by a 480V 3-phase circuit. Provide a separate 480/120 transformer panel-mounted adjacent to each 120V ac sludge panel.
 - D. Control panel components shall be installed inside a NEMA 4X-rated control panel housing. Outside installations shall include a solar shield and or ventilation fan, if required to maintain enclosure temperature. It shall be the responsibility of the sludge collector manufacturer to provide all necessary control hardware, programming, and components as required for a complete installation. Panel enclosure shall be aluminum or Type 304 stainless steel.
 - E. Provide a sun shield for human-machine interface on panels mounted outdoors, to prevent glare.
 - F. Refer to P&IDs I-003 and I-004 for additional details.
- 2.07 GROUT
- A. Meet requirements of Section 03 62 00, Grouting.
- 2.08 APPURTENANCES
- A. Lifting Lugs: Suitably attached for equipment assemblies and components weighing over 100 pounds.
 - B. Equipment Identification Plates: 16-gauge 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 equipment identification number and letters indicated on the Contract Documents.
- 2.09 FABRICATION
- A. Shop fabricate and assemble mechanism components in largest sections practicable for installation.
 - B. 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.
 - C. Shop/Factory Finishing:
 - 1. Shop prime and finish coat ferrous metal in accordance with and as specified in Section 09 90 00, Painting and Coating.
 - 2. Exposed metal surfaces of motors, gear reducers, assemblies, and covers shall be factory prepared and primed in accordance with Section 09 90 00, Painting and Coating.

2.10 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
- B. Factory Tests: Perform manufacturer's standard functional tests.

PART 3 EXECUTION

3.01 PREPARATION

- A. Level basin floors and wall straightness to within tolerances required by equipment manufacturer, which may exceed the concrete tolerance in Section 03 30 00, Cast-in-Place Concrete. The manufacturer's tolerance requirements shall govern if they are more stringent than specified concrete tolerances.
- B. In accordance with manufacturer's written instructions.
- C. Following completion of the concrete installation, measure resulting tolerances to confirm compliance with manufacturer's requirements. Manufacturer shall accept actual concrete tank tolerances in writing prior to equipment installation.
- D. Collector mechanism shall be run dry, for at least one complete revolution to clear wall and floor. Clearances between floor and collector mechanisms shall be in accordance with manufacturer recommendations. Concrete shall be ground to achieve these clearances.
- E. Units shall be run a minimum of 7 days in a wet condition without problems prior to introduction of treated water into the basin.

3.02 INSTALLATION

- A. Equipment shall arrive on-site unassembled in pieces capable of fitting through existing 3-foot by 3-foot access hatch. Contractor shall field-verify access hatch dimensions. Contractor shall bolt collector mechanisms pieces together inside basins in accordance with manufacturer's written instructions.
- B. The sludge collector exit pipe will require field welding to prevent leakage. Contractor shall install in accordance with manufacturer's written instructions. See Section 40 27 00, Process Piping—General for welding requirements. Grind all field welds smooth and apply pickling paste in accordance with manufacturer's instructions.

- C. Equipment shall be stored in a secure area in strict accordance with the manufacturer's drawings and recommendations prior to installation. Any control panels shall be stored in a secure and dry area.
- D. Install sludge collection equipment as indicated on the Contract Drawings and in accordance with the manufacturer's recommendations.
- E. Accurately place anchor bolts using templates furnished by manufacturer and in accordance with Section 05 50 00, Metal Fabrications.
- F. No field welding, except seal welding to provide specific degree of tightness against leakage, will be allowed.
- G. Cables must be installed by manufacturer's representative. The manufacturer's representative must be OSHA confined space certified. Contractor shall budget for manufacturer's time and travel accordingly.
- H. Cable proximity switches must be set by the manufacturer's representative. Contractor shall budget for manufacturer's time and travel accordingly.

3.03 FIELD FINISHING

- A. Touch-up of any damaged surfaces will only be permitted with Owner's approval. Manufacturer shall provide matching color and application instructions for minor repairs.

3.04 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each sludge collector as follows.
 - 1. Alignment: Prior to facility startup, test complete assemblies for oscillation, proper alignment and connection, quiet operation, excessive vibration, and satisfactory specified performance.
 - 2. Manufacturer shall verify proper installation of sludge collector system. Acceptance and approval of equipment installation and operation by manufacturer is required prior to startup. Submit documentation to Engineer.
 - 3. Demonstrate that all motors operate within power input criteria scheduled on the Contract Drawings.
- B. Performance Test: Confirm mechanical, electrical, and structural compliance with specified torque requirements.
 - 1. Sludge collector shall be able to remove up to a 2 percent solids concentration.

2. Limiting water waste shall be the focus of solids collection operations strategy. Given plant data, an operations and water waste scenario will be advised, and targets shall be met.

3.05 MANUFACTURER'S SERVICES

- A. Manufacturer shall provide a factory-trained representative to assist in supervision of installation, in startup and testing equipment, and in training Owner's staff in proper operation and maintenance of the equipment.
- B. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded.
 1. 4 person-days for installation assistance and inspection.
 2. 4 person-days for functional testing and completion of Manufacturer's Certificate of Proper Installation.
 3. 2 person-days for prestartup classroom or Site training.
 4. 8 person-days for facility startup.
 5. 4 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.
- C. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 44 42 38 BAFFLE WALLS

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. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - c. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - d. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - e. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - f. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - g. C581, Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service.
 - h. C920, Standard Specification for Elastomeric Joint Sealants.
 - i. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - j. D570, Standard Test Method for Water Absorption of Plastics.
 - k. D638, Standard Test Method for Tensile Properties of Plastics.
 - l. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - m. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.02 DESIGN CRITERIA

A. Design load, considered as uniform loading over the entire wall, should include fluid flow pressure.

1. Design Load: The load for design shall be based on water differential and fluid flow.
 - a. Water Differential: 6 inches (considered as a uniform load over the entire wall).

- b. Fluid Flow: 140 million gallons per day (mgd).
- c. Thermal Movement:
 - 1) Allow for maximum range of ambient temperature change (difference between high or low and installation temperature).
 - 2) Temperature Change Range: 100 degrees F, material surfaces.
- d. Deflection Limits and Factors of Safety:
 - 1) Baffle Panels Due to Lateral Loads: $L/D = 90$ (not to exceed 2.75 inches); factor of safety = 2.0.
 - 2) Baffle Panels and Support Structure due to vertical loads: $L/D = 360$; factor of safety = 2.0.
 - 3) Columns: $L/D = 100$, factor of safety = 2.5.

B. All materials must be NSF 61 certified.

C. Provide access doors where shown on the Contract Drawings.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings:
 - a. Detailed description of materials of construction. Provide information on laminate and type of reinforcing to be used if fabricating from fiberglass-reinforced plastic (FRP).
 - b. Manufacturer's drawings including layouts, connection and framing details, fastener types and spacing, product description, and installation guidelines. Drawings shall show dimensions of the items and accessories being provided and shall be stamped by a professional engineer licensed in the State of New Jersey.
 - c. Complete information regarding specific resin to be used.
- 2. Sample: Manufacturer's 6-inch square sample of FRP laminate of same construction, nominal thickness, and color as materials specified.

B. Informational Submittals:

- 1. Structural calculations stamped by a professional engineer licensed in the State of New Jersey.
- 2. Proof of NSF 61 certification.
- 3. Field repair methods and materials.
- 4. Manufacturer's warranty.
- 5. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, and stating the following:
 - a. Reinforcing material used will provide suitable chemical resistance.

- b. Resin is suitable for the environmental conditions intended and the fabrication technique proposed.

1.04 QUALITY ASSURANCE

- A. Contractor shall be responsible for verifying all field dimensions for development and approval of manufacturer's drawings.
- B. Baffle system components (excluding any associated concrete items) shall be provided by a single manufacturer to ensure coordination and compatibility of parts.
- C. Manufacturer of baffle wall system shall have full responsibility for products and design. Split responsibility of materials or design is not acceptable.
- D. Manufacturer of baffle wall system shall have completed within the last 5 years a minimum of five projects of similar type as those required in this scope.
- E. FRP components must be manufactured in the USA.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site or Contractor's off-site storage location properly packaged for ease of handling and to minimize damage during shipping.
- B. Handling and storage of items provided hereunder shall be in strict accordance with manufacturer's printed instructions. Care shall be taken not to damage components and accessories.

1.06 WARRANTY

- A. Provide manufacturer's warranty as specified in these Contract Documents.

PART 2 PRODUCTS

2.01 GENERAL

- A. Work covered by this section shall include materials and installation for the bolted FRP baffle wall system, which includes but is not limited to:
 - 1. FRP baffle wall panels.
 - 2. FRP columns.
 - 3. FRP angles.
 - 4. Column baseplates/angles.
 - 5. Fasteners and connections.

- B. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization of appearance, operation, maintenance, and manufacturers' services.
- C. Coordinate fabrication of baffle walls with flocculators, wash water monitors, basin piping, sludge collectors, support columns, walkways, ladders, handrails, etc. to ensure proper functioning of system.
- D. Provide access doors where shown on the Contract Drawings.

2.02 MATERIALS

- A. Baffle walls shall be constructed of FRP.
- B. Fiberglass:
 - 1. FRP structural materials shall exhibit these minimum physical properties:
 - a. Tensile Strength: 30,000 psi, ASTM D638.
 - b. Flexural Strength: 30,000 psi, ASTM D790.
 - c. Flexural Modulus: 2,00,000 psi, ASTM D790.
 - d. Izod Impact: 25, ASTM D756.
 - e. Water Absorption: .25 percent maximum, ASTM D570.
 - 2. FRP Baffle Panels:
 - a. FRP baffle panels shall be a ribbed profile in 2.75-inch depth by 24-inch height coverage (full panel dimension).
 - b. FRP baffle panels shall be minimum 1/4 inch (.25 inch) thick.
 - c. FRP baffle panels shall have (top) horizontal ribs that slope downward not less than 10 degrees to minimize sediment build-up.
 - d. FRP material shall include glass-fiber reinforcements 50 percent (minimum) of the material weight embedded within UV stabilized polyester resin. Color shall be standard gray.
 - e. FRP material shall have a surfacing veil on both top and bottom sides.
 - 3. FRP Structural Framing/Angles:
 - a. FRP angles shall be minimum 3/8-inch (.375-inch) thickness and 90 degrees.
 - 1) Manufacturer shall factory attach FRP angles to FRP columns (as applicable).
 - 2) Installing contractor shall field attach FRP angles to concrete structure or steel walls.
 - b. FRP material shall include glass fiber reinforcements 50 percent (minimum) of the material weight embedded within UV stabilized polyester resin. Color shall be standard gray.

- c. FRP material shall have a surfacing veil on both top and bottom sides.
- 4. Base plates or angles shall be factory attached unless noted otherwise on Drawings.
- C. Hardware:
 - 1. Fasteners, anchorage, and other structural hardware shall be Type 316 stainless steel.
 - 2. Fasteners shall use a double nut and lock washer to prevent loosening of connections.
- D. Pipe Penetrations: Pipe penetrations shall be field installed by Contractor. Penetrate baffle wall at 90-degree angles. Manufacturer shall provide instructions and all materials necessary for Contractor's use to prepare field cut surfaces.
- E. Manufacturers:
 - 1. NEFCO Systems, Inc.
 - 2. Midwestern Fabricators.
 - 3. Enduro Composites, Inc.
 - 4. "Or equal."

2.03 APPURTENANCES

- A. Anchoring: Type 316 stainless steel adhesive anchors as specified in Section 05 50 00, Metal Fabrications.

PART 3 EXECUTION

3.01 EXAMINATION

- A. At the time of delivery, all materials shall be inspected for shipping damage. The freight company and the manufacturer shall be notified immediately of any damage or quantity shortages.

3.02 INSTALLATION

- A. Install in strict accordance with the manufacturer's written instructions.
- B. The Contractor shall protect materials from cuts, scratches, gouges, abrasions, and impacts. When lifting crated materials, spreader bars shall be used (not wire slings unless materials are fully protected). Components shall not be dragged across one another unless separated by a non-scratching spacer.

- C. Before placing and attaching components, the contractor must confirm the alignment and location of column base plates, surfaces, brackets, saddles, etc. All bearing surfaces must be level, flat, clean and free of debris.
- D. Erection shall proceed according to sequence shown on the approved drawings.
- E. Contractor shall install pads, curbs, or piers to modify uneven or sloped concrete surfaces to create a flat, level surface for baffle system attachment.
- F. Contractor shall field cut materials as required and shown on the manufacturer's drawings.
- G. Contractor shall install beams and connections as shown on the approved layout drawings. Field modifications (cuts, copes, holes, etc.) unless shown on the drawings are not allowed without the manufacturer's written approval. Shim beams only with approved materials.
- H. Before placement of baffle panels, contractor shall check alignment and location of framing members and existing structure.
- I. Contractor shall adjust baffle panels for proper bearing and alignment.
- J. Contractor shall drill holes for fasteners through baffle panel and support beam.
- K. Contractor shall fasten baffle panels to structural supports as shown on the approved layout drawings. Unless noted otherwise, baffle panels shall be attached to each support according to manufacturer's recommendations with nut and bolt assemblies. Refer to manufacturer's installation instructions and drawings for proper fastener selection and procedure.
- L. Contractor shall place and fasten other miscellaneous components or hardware as shown on the approved drawings.

3.03 TESTS AND INSPECTION

- A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

3.04 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services. Present at Site, for minimum person-days listed below, travel time excluded:
 - 1. 5 person-days for installation assistance and inspection, and for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

END OF SECTION

SECTION 44 44 36
HORIZONTAL PADDLE FLOCCULATION SYSTEM

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 Gear Manufacturers Association (AGMA):
 - a. 2004-B89, Gear Materials and Heat Treatment Manual.
 - b. 6001-D97, Design and Selection of Components for Enclosed Gear Drives.
 - c. 6010-F97, Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives.
3. American Iron and Steel Institute (AISI).
4. American Society of Mechanical Engineers (ASME):
 - a. B1.20.1, Pipe Threads, General Purpose (Inch).
 - b. B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
 - c. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24.
5. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
6. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
7. NSF International (NSF): NSF/ANSI 61, Drinking Water System Components - Health Effects.
8. The Society for Protective Coatings (SSPC).

1.02 DESIGN

- A. A single manufacturer shall provide all necessary equipment, controls, and appurtenances for a complete working system whether or not items are shown on the Drawings or specified.
- B. The Contractor shall field verify basin dimensions, obstructions, and installation requirements. This information shall be conveyed to the manufacturer before preparation and submittal of shop drawings.

- C. There is approximately 2 feet of clearance between the flocculator shaft center line and ceiling. Sprockets and chain guard housing must fit in available space.

1.03 SUBMITTALS

A. Action Submittals:

1. Complete information required by data sheet attached at end of Specification as supplement.
2. Make, model, weight, and horsepower of each component.
3. Manufacturer's catalog information, descriptive literature, specifications, and materials of construction.
4. Data and design computations upon which design of paddle wheels are based, including mixing intensity (G), tip speed, power input, paddle arrangement, and structural calculations. Calculations shall also include feed water force against flocculation paddle wheel. Calculations shall be signed and sealed by an engineer registered in the State of New Jersey.
5. Data and design computations upon which design of drive mechanism's supports are based including maximum pullout and torque forces.
6. Detailed structural, mechanical, and electrical drawings showing equipment fabrications and interface with other items. Include dimensions, size, and details of anchorages and of connections to other work, and weights of associated equipment.
7. Template for anchor bolts and other connections.
8. Certification that entire submerged assembly is NSF/ANSI 61-compliant.
9. Motor nameplate data, in accordance with NEMA MG1, motor manufacturer, and any motor modifications.
10. Power and control wiring diagrams, including terminals and numbers.
11. Control panel layout drawings, and control schematics.
12. Information on proposed factory-applied coating system.
13. Method of chain tightening for drive chains.

B. Information Submittals:

1. A list of at least 10 previous installations, including contact information, of similar size, design, and complying with the requirements as set forth within this Specification.
2. Storage, handling, and installation instructions.
3. Field installation and testing procedures.
4. Functional test results.
5. Manufacturer's warranty.
6. Operation and maintenance data as specified in Section 01 78 23, Operation and Maintenance Data.

7. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for each flocculation mechanism installed.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
9. Service records for maintenance performed during construction.
10. Manufacturer's functional and performance test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Designer: Professional engineer registered in State of New Jersey.
2. Equipment shall be the product of a manufacturer engaged in the design and manufacture of similar equipment in successful operation in similar applications. The manufacturer shall have a minimum of 10 years of United States municipal water experience with 10 installations of the same type of equipment as specified herein with documented successful operation.
3. The naming of a manufacturer in this Specification is not an indication that the manufacturer's standard equipment is acceptable in lieu of the specified component features. Naming is only an indication that the manufacturer may have the capability of engineering and supplying a system as specified. Manufacturers shall not quote, submit, or supply any material not in full compliance with this Specification.
4. This Specification has been prepared on the basis of the specific requirements for this application. These specifications may require modification of manufacturer's standard equipment design and it will be mandatory that all manufacturers meet all requirement of this Specification. Equipment manufacturers shall modify their standard designs and recommended operational parameters to meet all requirements of this Specification and as shown on the Drawings.

1.05 SPARE PARTS

A. The following spare parts shall be provided by the equipment manufacturer:

1. One complete drive chain for each basin.
2. One complete set of upper and lower journal bearing liners for one basin.
3. One set of drive sprocket teeth.
4. One set of driven sprocket teeth.

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.06 WARRANTY

- A. Provide manufacturer's warranty as specified in these Contract Documents.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
 - 1. Jim Meyers & Sons, Inc.
 - 2. "Or-equal."

2.02 SERVICE CONDITIONS

- A. Process Description:
 - 1. Horizontal paddle flocculators will be installed in an underground covered basin. Motors and drives will be installed in the pipe gallery. See Drawings.
 - 2. Reuse existing concrete supports for flocculator bearings and shafts. See Drawings.
- B. Water Description: Surface water from Wanaque Reservoir.
- C. Basin Dimensions and Water Depths: See Contract Drawings.
- D. System Flow Rates:
 - 1. 12.5 mgd minimum capacity (per basin).
 - 2. 23,3 mgd design capacity (per basin).
 - 3. 35 mgd maximum capacity (per basin).
- E. Downstream Treatment Process: Settling and rapid sand filtration.
- F. General:
 - 1. Furnish each shaft in sections connected by ANSI flanges to facilitate installation and removal.
 - 2. Each shaft shall support five paddle assemblies.
 - 3. Shafts shall be aligned parallel to direction of flow.
 - 4. Each mixing basin shall contain four shafts that shall be counter-rotating to each other.
 - 5. Each flocculator shaft shall be driven by an individual drive.
 - 6. 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.

- a. Use or reuse of components and materials without a traceable certification is prohibited.
 - b. Systems that do not have ANSI/NSF-61 certification on the entire system as specified in the manufacturer's name will not be accepted.
7. Equipment shall be designed to accomplish mixing and tapered flocculation in the basins without shearing or destabilizing agglomerated floc particles.
 8. Equipment shall be designed to operate in basins having the dimensions indicated on the Drawings.
 9. Flocculation equipment shall operate in water having a design pH of 5.5 to 8 and water temperature range of 33 degrees F to 85 degrees F.
 10. Each basin shall have flocculators designed in accordance with the following requirements:

	Stage 1	Stage 2	Stage 3	Stage 4
Maximum gearbox output (rpm)	14.4	13.8	13.8	11.4
Flocculator stage width (feet)	15'-6"	15'-6"	15'-6"	15'-6"
Flocculator stage length (feet)	75'-6"	75'-6"	75'-6"	75'-6"
Average side water depth (feet)	15'-6"	15'-6"	15'-6"	15'-6"
Maximum velocity gradient (sec^{-1})	60	50	40	30
Minimum velocity gradient (sec^{-1})	50	40	20	10
Design temperature (degrees F)	33	33	33	33
Approximate flocculators diameter (feet)	12.5	12.5	12.5	12.5
Approximate blade size (inches x inches)	2 x 6	2 x 6	2 x 6	2 x 6
Maximum tip speed (fps)	3.0*	3.0*	3.0*	3.0*
Minimum motor horsepower (hp)	7.5	5	5	3

* Maximum tip speed in accordance with Ten State's Standards.

2.03 FLOCCULATORS

A. Shafts:

1. The shafting system for each mechanism shall be sized within stress limitations at full operating load and within deflection limitations under dry load.

2. Maximum shear shall be determined by combining bending and torsional stresses under full operating load through Mohr's circle stress convention. Maximum vertical deflection of the shafting system shall not exceed $L/1000$ between support reactions under dry load.
3. Type 304L stainless steel hubs shall be 1/2 inch thick minimum, and welded to the shafts for paddle arm connection. Welds shall be continuous on both sides of the hub plate. Manufacturing practices shall allow hub plates on adjacent shafts being in alignment with one another.
4. All shafting between bearings shall be Type 304L stainless steel hollow shafting, straight and true. Shafting at bearing locations shall be solid Type 17-4 pH stainless steel. Solid and pipe shaft sections shall be connected through a bolted flanged connection. Standard 150-pound ANSI flanges shall be used and manufactured from Type 304L stainless steel. Flange size shall be determined by pipe shaft diameter. A minimum 1/4-inch thick neoprene gasket shall be placed between each set of flanges.
5. All solid spool shafts at the bearing shall be Type 17-4 pH stainless steel using blind flanges, bored to the appropriate diameter for precise alignment, and contain continuous welds on both sides of the flange. Gusset plates shall be installed at each flange to reinforce the connection, with a minimum of 4. After fabrication, each shaft assembly's flanges shall be faced to within 0.005 inch of parallel to one another.
6. All pipe shafting shall use a blind flange, grooved to the appropriate diameter for precise alignment, and joined by means of a continuous watertight weld. After fabrication, each shaft assembly's flanges shall be faced to within 0.005 inch of parallel to one another.
7. Stage 1 and 2 pipe shafts shall be minimum 6-inch Schedule 40 pipe. Stage 3 and 4 pipe shafts shall be minimum 5-inch Schedule 40.

B. Stuffing Box:

1. Stuffing boxes will be fabricated carbon steel or T-304 stainless steel construction with bronze bushings and retainer gland. Stuffing box will be designed with a minimum of 6 rows of packing material and will incorporate a lantern ring located within the rows of packing for grease lubrication and sealing. An external grease fitting will be provided. Packing will be externally adjustable.
2. The flocculation equipment manufacturer will supply a steel wall sleeve with water stop for each stuffing box. Two sets of link seals will be provided for each wall sleeve.
3. Bearings shall be provided on the wet well and dry well side of the stuffing box to prevent excess wear on the stuffing box.

C. Bearings:

1. Submerged journal bearings shall have split cast stainless steel housings with Poly-Texx HPVT liners allowing for water lubrication. Liners shall be full bore length and removable without removal of bearing base.
2. Bearing Liner Properties:
 - a. Contain PTFE Teflon fibers as a solid lubricant uniformly dispersed throughout a high-strength thermoset resin system.
 - b. Minimum PV Rating: 40,000.
 - c. Minimum Specific Gravity: 1.33.
 - d. Minimum Ultimate Compressive Strength: 40,000 psi.
 - e. Minimum Rockwell M Hardness: 100.
3. Shaft bearings shall have a length to diameter ratio of 2.0.
4. Bottoms of bearing housings shall be machined to provide an accurate and uniform bearing area.
5. Stage 1 and 2 bearings shall be minimum 4-inch diameter. Stage 3 and 4 bearings shall be minimum 3.5-inch diameter.

D. Flexible Coupling:

1. The section of shafting between stuffing box and journal bearings shall be coupled with a new flexible disc coupling that allows for some misalignment of the shafts.
2. Coupling shall use a disc arrangement to allow for a minimum 1/2-degree angular misalignment.
3. Couplings shall have a theoretical infinite life at catalog rated values of torque and misalignment. The coupling shall be no longer than 12 inches long.
4. All components including hubs, spacer, and disc shall be stainless steel.
5. Flexible couplings shall be Rexnord's Thomas flexible close-coupled disc coupling series 54RD, Lovejoy's close-coupled split spacer disc coupling type SXCST-6, or Mega-COUPLING.

E. Bearing Base Plate Assemblies:

1. Bearings shall be mounted on fabricated Type 304 stainless steel base plates, minimum 1/2 inch thick. Bearing bases shall be slotted for coarse bearing alignment. Jack blocks and bolts shall be provided for fine bearing alignment and to lock bearings in place after alignment.
2. Each bearing and base plate sub-assembly shall be anchored to its supporting pier by Type 304 stainless steel anchors, minimum 5/8-inch diameter, that allow for 2-inch leveling adjustment.
3. Bearing bases shall be grouted in place after dry startup and confirmation of bearing alignment.
4. Concrete bearing support piers shall be as required by manufacturer. Pier elevation, width, and length shall be confirmed with manufacturer.

F. Flocculation Paddle Assemblies:

1. Flocculator paddles shall be nominal 2 inches by 6 inches pultruded fiberglass channel. Paddles shall be bolted to paddle arms with two 1/2-inch bolts and nylon insert lock nuts at each connection.
2. Paddles shall be held in place and supported by stainless steel angle arms bolted to fabricated stainless steel shaft hubs with two 5/8-inch bolts and nylon insert locknuts. Paddle arms shall be sized for tip deflection of no more than 1/360, and shall be no smaller than L3 x 3 x 1/4-inch angles.

G. Drive Motor:

1. Integral gearmotors shall be energy-efficient squirrel cage, induction type with totally enclosed fan-cooled frames. Insulation shall be Class F minimum. Maximum temperature rise above ambient shall not exceed the value specified for Class B rise. Motors shall be VFD duty.
2. Motors shall have 120-volt windings space heaters to prevent internal condensation. Thermostat overload protection shall be embedded in the windings.
3. Electrical characteristics shall be 460 volts, 3-phase, 60-Hz. Motors shall be provided with 1.15 service factor.
4. Motors shall be equipped with oil or grease lubricated anti-friction bearings have a minimum of L-10 life of 80,000 hours, as defined by AFBMA.
5. Rating of motors shall be adequate to continuously drive flocculators under any condition of operation but shall not be less than specified above.
6. Manufacturers:
 - a. SEW Eurodrive.
 - b. Baldor.
 - c. "Or-equal."

H. Gear Reducers:

1. Drive units shall be as manufactured by SEW Eurodrive and contain wash-down duty features.
2. Each drive unit shall be constant speed and designed to provide speed and output torque as required by process design. Gearbox shall be parallel helical or helical bevel gearing as required by Site constraints.
3. Each drive unit shall be designed and arranged for rotation as indicated on the Drawings.
4. Each gear reducer shall be a heavy-duty, foot-mounted, concentric gear unit completely enclosed in a housing of cast iron or fabricated steel construction. Gear reducer shall be specifically designed for the application intended and shall be suitable for connection to the output shaft. General maintenance, specifically including motor changes, gear

changes, bearing replacement and maintenance of the oil lubricating system shall not require removal of the gear reducer housing from its mounting base.

5. The gear reducer shall be designed and rated for a minimum of AGMA II with a service factor of 1.2 applied to the motor nameplate rating or 1.5 applied to the process load, whichever is greater.
6. All gearing shall be designed, constructed, stamped and rated for the AGMA service factor specified herein.
7. Thermal rating of gear reducer shall exceed design mechanical rating to preclude the need for external cooling equipment. External cooling devices are not acceptable.
8. Gear reducer output shaft shall be constructed and supported so that shaft deflection caused by operating loads does not affect alignment of the reducer bearings or cause misalignment of the gearing during flocculator operation. All bearings in the speed reducer shall be anti-friction type and shall have a minimum L-10 life of 100,000 hours. Internal bearing life calculation using the Wesilab program shall be provided. Units shall be oil-lubricated. All gears and bearings shall be protected from rusting during storage by application of a shop-applied protective coating.

I. Drive Base Plate Assembly:

1. Drives shall be mounted on adjustable drive base plate assembly. The drive base plate assembly shall consist of a sole plate, a leveling plate, four 1-inch diameter all thread leveling rods with stainless steel nuts to adjust drive unit elevation and allow for chain tensioning. A chain adjusting system using an idler sprocket or other means of chain tensioning shall not be acceptable.
2. Sole plate shall be Type 304L stainless steel, minimum 3/4 inch thick, and slotted for proper drive alignment. Sole plate is grouted in place after alignment confirmation.
3. Leveling plate shall be Type 304L stainless steel and designed for all drive system loads, with a minimum 5/8 inch thickness. The leveling plate shall be capable of elevation adjustment providing for maximum required take-up of the drive chain with a minimum of 4 inches.
4. Each drive unit assembly shall be installed on a concrete base support and shall be coupled to the flocculator shaft, as indicated on the Drawings. The concrete base support shall be as required by the manufacturer.

J. Drive Chain and Sprockets:

1. Drive chains shall be No. 120 roller chain with chain tension rating of 8,000 pounds per foot minimum.

2. Chains shall be permanently sealed with lubricant in the factory and require no external lubrication.
 3. Chain shall be manufactured with boron steel pins, chrome-molybdenum alloy bushings, and heat-treated alloy steel roller and side plates.
 4. Drive and driven sprocket shall consist of a steel body and flame-hardened teeth.
 5. Drive sprocket shall have minimum 20 teeth.
 6. All sprocket hardware shall be Type 316 stainless steel.
 7. Sprocket arrangement shall be designed so maximum chain tension does not exceed working load of the chain. Maximum ratio obtained through the drive and driven sprocket is 3:1.
 8. Provide a Type 304 stainless steel chain guard for the portion of the chain that extends above the operating level.
- K. Mechanical Torque Overload: Drive system shall be provided with mechanical over torque protection that allows the shaft to slip when load exceeds a predetermined torque. No electronic feedback is required to the control panel. Either ball detent or friction discs can be used.
- L. Control Panel:
1. Four control panels, each including four variable frequency drives (VFDs), control power transformer, over-current protection device and control devices for each unit shall be provided. The VFD and control panel provided under these Specifications shall meet the requirements of Division 26, Electrical.
 2. Refer to I&C Specifications Section 40 90 00, Instrumentation and Controls Scope of Work and Section 40 95 13, Fabricated Control Panels for details regarding programmable logic controller (PLC) control panel hardware.
 3. VFD shall provide overload protection for the gear motor and the gear reducer. Overload torque, at which the VFD torque overload trips and alarms, shall not be more than 150 percent of normal running torque.
 4. VFDs shall be by Emerson (“or-equal”), each with a ProfiNet interface adapter that connects and communicates to the corresponding flocculator PLC system.
 5. Control panel shall be Type 316 stainless steel construction conforming to NEMA 4X requirements and suitable for wall or stand mounting by the Contractor. An adequately sized hinged front access panel shall be provided to allow access to all internal components.
 6. Control panel shall be provided with an air-conditioner to ensure the internal temperature will not exceed maximum temperature rating of the panel-mounted devices and VFD. The air-conditioner shall be mounted on the side of the control panel and shall not violate the panel’s NEMA 4 rating.

7. Control panel shall be factory-wired and tested with clearly identified, industrial type terminal strips for all external field connections.
8. The following control devices shall be mounted on the front door of the control panel:
 - a. Flange-mounted disconnect switch lockable in the OFF position.
 - b. Power indicating light.
 - c. Run indicating light (PTT).
 - d. Stop indicating light (PTT).
 - e. Fault indicating light (PTT).
9. The VFD keypad will be used for local control:
 - a. Local/Off/Remote selector.
 - b. Start.
 - c. Stop.
 - d. Speed indication.
 - e. Speed setting.
 - f. Motor elapsed-time indication.
10. The following Flocculator VFD signals interface with the plant control system via Ethernet:
 - a. Speed control signal.
 - b. Speed indication.
 - c. Run status.
 - d. Common fault status.
 - e. Remote status.

M. Fabrication:

1. All welded joints that will be fully or partially submerged shall be sealed watertight with continuous welds. All welding shall be performed in accordance with AWS standards.
2. All parts and components shall be factory-assembled in sections convenient for field handling and installation but requiring the minimum amount of work for field assembly. Any field assembly work shall be bolted. No cutting or welding should be required on either field assembly or erection.
3. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
4. All assembled parts and components ready for shipment shall be securely bundled, coiled, or crated and adequately protected from damage and corrosion during shipment and storage.

N. Lubricants and Lubricating Equipment:

1. Provide and install necessary food-grade quality oils, greases, and anti-seize compounds for initial operation of all equipment provided that requires oil, grease, or anti-seize.

2. Food-grade anti-seize shall be applied to the threads of all stainless steel bolts before assembly at the factory and field assembly.

O. Surface Preparation:

1. Submerged and non-submerged cast iron and fabricated carbon steel components shall be shop blasted and painted in accordance with the following.
 - a. SSPC-SP10 near white blast cleaning with a 1.5-mil to 2.0-mil surface blast profile.
 - b. Primer: Tnemec Series V140F-1255 Potapox Plus beige primer 4.0 to 6.0 dry mils.
 - c. Finish: Tnemec Series V140F-15BL Potapox tank white finish 4.0 to 6.0 dry mils.
2. Stainless steel, fiberglass, and UHMW-PE shall not be painted.
3. Drive unit shall include manufacturer's standard wash-down duty paint system.
4. All stainless steel shall be dip passivated in compliance with ASTM A380.

2.04 ACCESSORIES

- A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- B. 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 equipment identification number and letters as shown on the Contract Drawings.
- C. Anchor Bolts:
1. Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications. Minimum 1/2-inch diameter unless approved by the Engineer.
 2. All submerged connections shall use Type 316 stainless steel nylon insert locknuts.
- D. Fasteners:
1. All field-assembly bolts and anchor bolts, nuts, and washers shall be Type 316 stainless steel and as specified in Section 05 50 00, Metal Fabrications.
 2. All submerged connections shall use Type 316 stainless steel nylon insert locknuts.

2.05 SOURCE QUALITY CONTROL

A. Functional Tests:

1. Test all components including control panels and electrical equipment. All variable speed and gear-reduction assemblies shall be shop tested prior to shipment. The speed reduction assemblies shall be run with rust-inhibiting oil.
2. Motors: Short commercial test.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Equipment shall arrive on-site unassembled in pieces capable of fitting through existing 3-foot by 3-foot access hatch. Contractor shall field verify access hatch dimensions. Contractor shall field assemble mechanisms inside basins according to manufacturer's written instructions.
- B. In accordance with manufacturer's written instructions and drawings, and details as shown on Contract Drawings.
- C. The shaft shall be aligned within 0.032 inch between bearing and within 0.065 inch over the entire shaft length.
- D. Anti-seize thread lubricant shall be applied to the male threads of all stainless steel bolts at the time of the assembly.
- E. Anchor Bolts: Accurately place using templates furnished by equipment manufacturer and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each flocculator as follows.

1. Alignment: Prior to facility startup, test complete assemblies for correct rotation, proper alignment and connection, quiet operation, excessive vibration, and satisfactory specified performance.
2. Manufacturer shall verify proper installation of flocculator system. Acceptance and approval of equipment installation and operation by manufacturer is required prior to startup. Submit documentation to Engineer.
3. Perform manufacturer's standard, test on equipment.
 - a. The manufacturer shall provide startup reports covering both dry and wet startup activities. These reports shall include system voltage and amperage readings at 20 percent and 100 percent speed.

3.03 MANUFACTURER'S SERVICES

- A. Manufacturer's representative shall assist in supervision of installation, in startup and testing equipment, and in training Owner's staff in proper operation and maintenance of the equipment.
- B. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 4 person-days for installation assistance and inspection.
 - 2. 4 person-days for functional testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 2 person-days for prestartup classroom or Site training.
 - 4. 8 person-days for facility startup.
 - 5. 4 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.
- C. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification:
 - 1. Flocculation Equipment Data Sheet (to be completed by manufacturer and submitted).

END OF SECTION

FLOCCULATION EQUIPMENT DATA SHEET

EQUIPMENT MANUFACTURER:

Name: _____

Address: _____

Telephone: _____

EQUIPMENT DATA (Note: Fill one figure only if item common to all stages):

	1st Stage	2nd Stage
Paddle Wheels Diameter		
Tip Speed		
Number of Arms		
Number of Paddles		
Paddle Size		
Paddle Material		
Shaft Diameter		
Shaft Material		

FLOCCULATION EQUIPMENT DATA SHEET

DRIVE MECHANISM (Note: Fill one figure only if item common to all stages):

SHAFT BEARING TYPE AND LUBRICANT	
Intermediate	
Supporting End	
Driven End	
VARIABLE-SPEED DRIVE	
Motor Type	
Speed Ratio	
GEAR REDUCER	
Type	
Speed Ratio	
Rating (AGMA)	
Minimum Speed at Flocculators (rpm)	
PERFORMANCE DATA	
Min G (sec ⁻¹) at 10 degrees C	
Min G (sec ⁻¹) at 10 degrees C	

DRAWINGS
(BOUND SEPARATELY)
