CITY OF PUNTA GORDA

SHELL CREEK WATER TREATMENT PLANT SULFURIC ACID FEED SYSTEM IMPROVEMENTS

CLIENT PROJECT NO. B2023130

TECHNICAL SPECIFICATIONS

BID SET

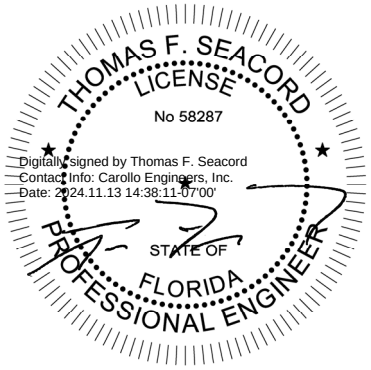
VOLUME 1 OF 1

NOVEMBER 2024

301 NORTH CATTLEMEN ROAD, SUITE 302 ▪ SARASOTA, FLORIDA 34232 ▪ P 941-371-9832

CITY OF PUNTA GORDA

SHELL CREEK WATER TREATMENT PLANT SULFURIC ACID FEED SYSTEM IMPROVEMENTS



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CITY OF PUNTA GORDA

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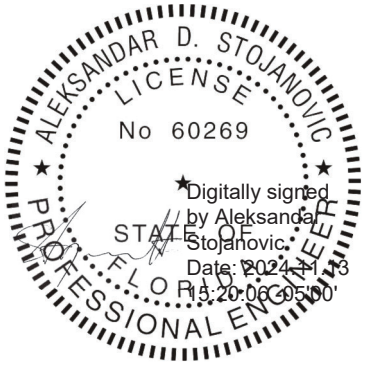

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CITY OF PUNTA GORDA

SHELL CREEK WATER TREATMENT PLANT SULFURIC ACID FEED SYSTEM IMPROVEMENTS

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SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Detailed description of the Work.

1.02 THE WORK

A. The Work consists of demolition and construction of the following items, all of which shall be constructed in accordance with the Drawings and Specification:
   1. Construction of sulfuric acid feed system improvements at the Shell Creek Water Treatment Plant.
   2. Work for the sulfuric acid feed system improvements includes the removal and proper disposal of sulfuric acid transfer and feed piping from the existing sulfuric acid bulk storage tank to both points of sulfuric acid injection (pre-treatment and post-treatment). The improvements consist of providing new transfer, feed, and side stream piping, valves, and appurtenances as defined in the Contract documents and specifications. The work also includes disinfection, testing, and other incidental tasks necessary to complete the project.

B. Restore disturbed areas of the site when work is completed.

C. See specification Section 01140 – Work Restrictions, for construction (shutdown, wash water supply, and staging) constraints and protection of treatment plant processes during construction.

1.03 LOCATION OF PROJECT

A. The Work is located at the City of Punta Gorda's Shell Creek Water Treatment Plant. The address is 38100 South Washington Loop Road, Punta Gorda, Florida 33982.

1.04 COORDINATION MEETINGS

A. Contractor shall attend the following meetings:
   1. Construction kickoff meeting.
   2. Weekly progress meetings.

B. Prior to each meeting, Contractor shall distribute a three week look ahead schedule and updated progress schedule.

1.05 PARTIAL USE OR OCCUPANCY

A. Substantial Completion on the following portions of Work for Owner's occupancy including specified testing, training of Owner's personnel, and other preparations necessary for Owner's occupancy or use:
   1. The sulfuric acid feed system improvements have been successfully implemented and installed, and are adequately delivering chemical, as defined in the design criteria, to the specified chemical injection points.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01116

CONTRACT DOCUMENT LANGUAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Explanation of arrangement, language, reference standards, and format.

1.02 REFERENCES

A. Construction Specifications Institute (CSI):
   1. MasterFormat™.
   2. SectionFormat™.
   3. PageFormat™.

1.03 PROJECT MANUAL ARRANGEMENT

A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.

B. Sections are written in CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.

C. Page format for Sections in the Project Manual is in PageFormat™, except where departures have been deemed necessary.

1.04 CONTRACT DOCUMENT LANGUAGE

A. Specification Section Paragraphs entitled "Section Includes" summarize briefly what is generally included in the section.
   1. Requirements of Contract Documents are not limited by "Section Includes" paragraphs.

B. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the Contractor shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all."
   1. Assume missing portions by inference.

C. Phrase "by Engineer" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.

D. Phrase "to Engineer" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

E. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
   1. When used as an appositive after designation of product, colons are used in place of words "shall be."

F. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, or render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.

G. Words "Contractor shall" are implied when direction is stated in imperative mood.

H. Term "products" includes materials and equipment as specified in Section 01600 - Product Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

1.02 SUBMITTALS

A. Baseline Schedule with MOP tasks.

B. Method of Procedure (MOP) Form.

C. Method of Procedure (MOP) Log.

D. Progress Schedule with MOP tasks.

1.03 GENERAL CONSTRAINTS ON WORK AND SCHEDULING OF WORK

A. Parking for Contractor shall be within areas designated by the Owner.

B. Work shall be conducted between the hours of 7 am to 4 pm on Monday through Friday. Work outside these hours and days is prohibited.

C. Water projects:
   1. The Shell Creek Water Treatment Plant is the Owner’s sole source of drinking water.
   2. Conduct Work such that the Owner’s ability to meet its customer's demands for treated drinking water shall not be impaired or reduced in terms of the required quantity or quality of treated water.
   3. Do not impair the operational capabilities of essential elements of the treatment process or reduce treatment capacity below levels sufficient to meet demands for water throughout the contract time. The quantities of and quality of treated water required are described in this Section.
   4. The status of the treatment plant shall be defined as “operational” when the plant is capable of meeting the Owner’s customer’s demands for treated drinking water in terms of the required quantity or quality of treated water as defined in this Section.

1.04 SHUTDOWN CONSTRAINTS

A. General shutdown constraints:
   1. Execute the Work while the existing facility is in operation.
   2. Some activities may be accomplished without a shutdown.

3. Apply to activities of construction regardless of process or work area.
4. Activities that disrupt plant or utilities operations must comply with these shutdown constraints.
5. Organize work to be completed in a minimum number of shutdowns.
6. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
7. Shutdown MOPs:
    a. Advise the Engineer a minimum of 3 weeks prior to need for any complete or partial plant shutdown for tie-ins.
    b. Prepare and submit MOP to Engineer for any complete or partial plant shutdown required a minimum of 2 weeks prior to the shutdown.
    c. Owner's written approval of MOP is required prior to beginning Work.
8. Where required to minimize treatment process interruptions while complying with specified constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.
9. Final determination of the permitting of shutdowns will be the sole judgment of the Owner.
10. Owner maintains the ability to abort on the day of the scheduled shutdown.
11. Unplanned shutdowns due to emergencies are not specified in this Section.

1.05 WORK RESTRICTIONS

A. Provide safe, continuous access to process control equipment for plant operations and maintenance personnel.

B. Piping:
    1. Provide temporary piping during construction for existing and new equipment to maintain plant operation in service during construction.

C. Sulfuric Acid Feed:
    1. Following the successful installation, testing, and operation of the post-treatment sulfuric acid feed system, pH adjustment at the pre-treatment sulfuric acid injection point must be conducted in a gradual and controlled manner prior to decommissioning the pre-treatment sulfuric acid feed for enhancements. The feed pH should be incrementally increased by 0.1 to 0.2 pH units per week, with continuous monitoring of normalized permeate flow, differential pressure, and salt rejection, until the acid dosing is completely eliminated.
    2. After the pre-treatment sulfuric acid feed has been effectively tapered to a no-acid feed state, the pre-treatment sulfuric acid feed piping can be dismantled and disposed of in accordance with the proposed improvements detailed and illustrated in the Contract Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - METHOD OF PROCEDURE (MOP)

"METHOD OF PROCEDURE" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	No later than 7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	No later than 7 days prior to work
Contractor	6. Complete Readiness Checklist.	No later than 5 days prior to work
Contractor	7. Complete Safety Checklist.	Immediately prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submits 3 copies for approval to the Owner's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in Contract Documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the Work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete Work.

Contractor completes Work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

ATTACHMENT B - METHOD OF PROCEDURE (MOP) FORM

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ **Date:** _____

Contractor: _____ **Carollo Project No.:** _____

Project Name: _____ **Submittal No.:** _____

Submittal Title: _____ **Spec/Drawing. Ref.:** _____

MOP #:	TASK TITLE: *(Provide <10 word title)*	SUBMITTAL DATE: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY:

START: *(Date/Time)* END: *(Date/Time)*

REQUESTOR:

PRIMARY POINT OF CONTACT:	PHONE/PAGER:
SECONDARY POINT OF CONTACT:	PHONE/PAGER:

NOTIFY: ☐	Control Room, Phone:	☐	Security, Phone:

BUILDING:	LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e. control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT / TOOLS: *(Pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark
☐	Energized Electrical Work	☐	High Pressure Test	☐	
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐	

EXISTING SERVICE(S) AT RISK:							
☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	
☐	Elect. Emergency	☐	Natural Gas	☐	Storm Drain	☐	
REVIEWER'S INSTRUCTIONS/COMMENTS:							
☐	PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:						

	Full Name (printed)	**Signature**	**Phone**	**Date**
Submitted By				
System Owner				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				

ATTACHMENT C - READINESS CHECKLIST

READINESS CHECKLIST

(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____

2. Review work plan: _____

3. Review contingency plan: _____

ATTACHMENT D - SAFETY CHECKLIST

SAFETY CHECKLIST

(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
   a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
   a. Lockout/tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook.
   b. ARC flash protection.
   c. Fire extinguisher.
   d. Other: _____
7. Accidents:
   a. Should accidents occur, do not shut off and do not attempt to correct the situation unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

ATTACHMENT E - METHOD OF PROCEDURE (MOP) LOG

METHOD OF PROCEDURE (MOP) LOG
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (Yes/No)
001					
002					
003					

SECTION 01220

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Procedures for measurement and payment of Work under this Contract for lump sum items and unit prices.

1.02 LUMP SUM ITEMS

A. Item 1: Mobilization.
   1. Measurement:
      a. Limit amounts included under mobilization to the following items:
         1) Moving on the site any equipment required for first month operations.
         2) Installing any necessary temporary construction power, wiring, and lighting facilities.
         3) Establish and submit hurricane preparedness plan.
         4) Establish and submit fire protection plan and safety program.
         5) Provide temporary facilities as specified in Section 01500 - Temporary Facilities and Controls.
            a) Providing on-site sanitary facilities and potable water facilities as specified.
            b) Providing field office trailer for the Contractor, if desired.
         6) Arranging for and erection of Contractor's work and storage yard.
         7) Submit required insurance certificates and bonds.
         8) Obtaining required permits, licenses, and fees.
         9) Submit preliminary schedule of values of the Work.
         10) Submit preliminary schedule and develop baseline schedule.
         11) Submit Schedule of Submittals.
         12) Post OSHA, Department of Labor, state, and other required notices.
         13) Submit pre-construction photographs.
         14) Have Contractor's project manager and/or general superintendent on job site.
   2. Payment:
      a. Furnish data and documentation to substantiate the amounts claimed under mobilization costs.
      b. Payment for mobilization shall not be made until mobilization items listed above have been completed as specified.
      c. Limit price for mobilization to no more than 5 percent of Contract Price.
      d. Lump sum.

B. Item 2: Removal and Disposal of existing sulfuric acid piping, valves, and appurtenances:
   1. Measurement:
      a. Demolish and dispose of existing sulfuric acid feed piping, valves, and appurtenances to both the pre-treatment and post-treatment sulfuric acid injection points as shown in the Contract drawings.
   2. Payment:
      a. Lump Sum.

C. Item 3: Provide sulfuric acid transfer piping (PVDF) from existing bulk storage tank to existing day tank.
   1. Measurement:
      a. Provide sulfuric acid transfer piping (PVDF), as specified and shown on the Contract drawings.
   2. Payment:
      a. Lump Sum.

D. Item 4: Provide sulfuric acid suction and discharge piping (PVDF) from existing day tank to the existing sulfuric acid injection pumps, and from the discharge of the existing sulfuric acid injection pumps to the point of PVDF to CPVC and PTFE tubing transition.
   1. Measurement:
      a. Provide sulfuric acid suction and discharge piping (PVDF) within the sulfuric acid feed room as specified and shown on the Contract drawings.
   2. Payment:
      a. Lump Sum.

E. Item 5: Provide sulfuric acid feed piping (PTFE tubing in CPVC containment) from the transition point (sulfuric acid feed room wall) to the pre-treatment and post-treatment injection locations.
   1. Measurement:
      a. Provide sulfuric acid feed piping (PTFE tubing in CPVC containment) to both sulfuric acid injection locations as specified and shown on the Contract drawings.
   2. Payment:
      a. Lump Sum.

F. Item 6: Provide sulfuric acid side stream piping, valves, appurtenances, and side stream injection panel.
   1. Measurement:
      a. Provide sulfuric acid side stream piping, valves, appurtenances, and side stream injection panel as specified and shown on the Contract drawings.
   2. Payment:
      a. Lump Sum.

G. Item 7: Demobilization:
   1. Measurement:
      a. Removal of temporary facilities as specified in Section 01500 - Temporary Facilities and Controls.
      b. Completion of closeout submittals as specified in Section 01770 - Closeout Procedures.

2. Payment:
    a. Shall not be less than 5 percent of Contract Price.
    b. Lump sum.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01292

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for preparation, format, and submittal of Schedule of Values.

1.02 PREPARATION

A. Schedule of Values shall be a listing of all cost loaded, on-site construction activities from the progress schedule, listed in numerical order, showing that the sum total of all cost-loaded activities equal the Contract value.

B. When the schedule is changed or revised to include added or deleted work, the Schedule of Values shall also be revised such that the sum total of all cost-loaded activities continuously equal the current Contract value.
   1. Equate the aggregate of these costs to the Lump Sum Contract Price.

C. Prepare Schedule of Values identifying costs of Major Items of Work.

D. Divide the work into the following Major Items of Work:
   1. Mobilization.
   2. Removal and Disposal of existing sulfuric acid piping, valves, and appurtenances.
   3. Provide sulfuric acid transfer piping.
   4. Provide sulfuric acid suction and discharge piping.
   5. Provide sulfuric acid feed piping.
   6. Provide sulfuric acid side stream piping, valves, appurtenances, and injection panel.
   7. Demobilization.

1.03 SUBMITTALS

A. Submit Schedule of Values for the Preliminary Schedule as specified in, Section 01321 - Schedules and Reports.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01294

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for preparation and submittal of Applications for Payment.

1.02 FORMAT

A. Develop satisfactory spreadsheet-type form generated by downloading cost data from the Progress Schedule.
   1. Submit payment requests and attach spreadsheet with cost data related to Progress Schedule.

B. Fill in information required on form.

C. When Change Orders are executed, add Change Orders at end of listing of scheduled activities:
   1. Identify change order by number and description.
   2. Provide cost of change order in appropriate column.

D. After completing, submit Application for Payment.

E. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.

F. Execute application with signature of responsible officer of Contractor.

1.03 SUBSTANTIATING DATA

A. Provide Substantiating Data identifying:
   1. Project.
   2. Application number and date.
   3. Cost flow summary.
   4. Updated schedule of values.
   5. Progress schedule.
   6. Detailed list of enclosures.
   7. Stored products log.
   8. Equipment log.
   9. Submit “certified” payroll, if applicable.
   10. Record (as-built) documents.
   11. Photos and videos from current pay period.
   12. Applicable unconditional waiver and release on progress payment for previous payment made by Owner.

1.04 SUBMITTALS

A. Submit Application for Payment and Substantiating Data with cover letter.

1.05 PAYMENT REQUESTS

A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.

B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.

C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format.

D. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.

E. Prepare summary of cost information for each Major Item of Work listed in the Schedule of Values. Identify the value of work completed for both the payment period and job to date.

F. Payment period:
   1. Monthly Application for Payment period shall begin on the 1st day of each month, and end on the last day of each month.
   2. Submit Application for Payment to Engineer no later than the 5th day of each month for work completed the previous month.
   3. Engineer will finalize and submit recommendation for Application for Payment to Owner by the 15th day of each month to allow time for processing and approval.

1.06 COST SUMMARIES

A. Prepare Summary of Cost Information for each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.

B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01321

SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Schedules and reports.

1.02 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Baseline schedule: A planned and approved timetable projection that illustrates the project execution strategy, key deliverables, planned activity dates and milestones.
   2. Critical path: The longest sequence of dependent tasks in a project.
   3. Near critical path: The longest path after the critical path.
   4. Weather day: The Contractor being prevented or inhibited from performing at least 4 hours of work on the critical path due to weather conditions.

1.03 SCHEDULING FORMAT

A. Utilize critical path method (CPM) format.

B. Provide a cost and labor loaded Schedule.

C. Engineer approval of the format is required.

1.04 SCHEDULING HARDWARE AND SOFTWARE

A. Scheduling software and hardware shall be located on-site.

B. Prepare computerized schedule utilizing the most current version of Oracle Primavera P6 or Asta Powerproject.

C. Contractor and Engineer must agree on the format.

1.05 SCHEDULE PREPARATION

A. Preparation and submittal of Progress Schedule represents Contractor’s intention to execute the Work within specified time and constraints.

B. All costs associated with Schedule requirements are included in the Contract Price.

C. During preparation of the preliminary Progress Schedule, the Engineer will facilitate Contractor’s efforts by answering questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

D. Prepare Schedule utilizing precedence diagramming method (PDM).

E. Prepare Schedule utilizing activity durations in terms of working days.
   1. Do not exceed a 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
   2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
   3. Coordinate holidays to be observed with the Owner and incorporate them into the Schedule as non-working days.

F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract.
   1. Contract requirements are not waived by failure of Contractor to include required Schedule constraints, sequences, or milestones in Schedule.
   2. Contract requirements are not waived by Owner's acceptance of the Schedule. In the event of conflict between accepted Schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.

G. Reference Schedule to working days beginning with Notice to Proceed as Contract Time as Day "1".

H. Baseline Schedule and project completion:
   1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor's Schedule completion date.
   2. Adjust accordingly any Contract milestone dates.

I. Imposed dates and hidden logic are prohibited.

J. Interim milestone dates, operational constraints:
   1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on Schedule.
   2. Do not use zero total float constraint or mandatory finish date on such Contract requirements.

K. Contract float is for the mutual benefit of both Owner and Contractor.
   1. Changes to the Project that can be accomplished within this available period of float may be made by Owner without extending the Contract Time by utilizing float.
   2. Time extensions will not be granted nor delay damages owed until Work extends beyond currently accepted Contract completion date.
   3. Likewise, Contractor may utilize float to offset delays other than delays caused by the Owner.
   4. Mutual use of float can continue until all available float shown by Schedule has been utilized by either Owner or Contractor, or both. At that time, extensions of the Contract Time will be granted by Owner for valid Owner-caused or third party-caused delays which affect the planned completion date and which have been properly documented and demonstrated by Contractor.

5. Non-sequestering of float: Pursuant to float sharing requirements of Contract, Schedule submittals can be rejected for use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, extended activity durations, or imposed dates.

L. Resource loading and leveling:
   1. Input labor data on each schedule activity.
   2. Manpower data consists of the man-hours estimated to perform each task, categorized by trade.
   3. Provide leveled manpower requirements.
      a. Availability of the resources drive activity duration.

M. Cost loading: All schedules:
   1. Only on-site construction activities.
   2. The sum total of all cost loaded activities equal to the current value of the Contract, including change orders, at all times.
   3. Payment for mobilization or payment for materials or equipment delivered to the site, not yet incorporated into the Work.
   4. Owner acceptance of the Baseline Schedule creates the Schedule of Values required as specified in Section 01292 - Schedule of Values.
   5. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01294 - Applications for Payment.
   6. Payments will not be made until the updated Schedule of Values is accepted.

N. Schedule logic:
   1. Assembled to show order in which Contractor proposes to carry out Work, indicate restrictions of access, availability of Work areas, and availability and use of manpower, materials, and equipment.
   2. Form basis for assembly of schedule logic on the following criteria:
      a. Which activities must be completed before subsequent activities can be started?
      b. Which activities can be performed concurrently?
      c. Which activities must be started immediately following completed activities?
      d. What major facility, equipment, or manpower restrictions are required for sequencing these activities?

O. Major subcontractor, parallel prime contractor sign off:
   1. Provide written confirmation of concurrence from all major subcontractors and independent prime contractors on site with all Schedule submittals.
   2. Term “major subcontractor” as used in this Section means any subcontractor, at any tier, with a subcontract worth 5 percent or more of the total cost of the Work.

P. Schedule windows for Owner-furnished, Contractor-installed equipment or materials:
   1. Immediately after Award of Contract, obtain from Engineer anticipated delivery dates of Owner furnished equipment or materials.
   2. Show these dates in the Schedule in same manner indicated by the Engineer.

1.06 SUBMITTAL REQUIREMENTS

A. Preliminary and Baseline Progress Schedule.

B. Preliminary and Baseline Schedule of Values.

C. Preliminary and Baseline Schedule of Submittals.

D. On a monthly basis, updated Schedules as specified.

E. Final Schedules update as specified.

F. Revised Schedules and time impact analyses as specified.

G. Submit Schedules in the media and number of copies as follows:
   1. PDF format and in other formats specified in this Section.
   2. 2 sets of CPM Schedule data electronic files in a native backed-up file format.

1.07 GANTT CHART

A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram.
   1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.

B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.

C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished.
   1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.

D. Provide Progress Schedule showing the critical path for the Project.

E. Provide report of Near Critical Path activities for the Project, when required by the Engineer.

F. Delineate the specified Contract Times and identify the planned completion of the Work as a milestone.
   1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as Project float.

G. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion dates as milestones.

H. Include, in addition to construction activities:
   1. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
   2. Equipment and long-lead material deliveries over 8 weeks.
   3. Approvals required by regulatory agencies or other third parties.

I. Produce electronic network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

1.08 PRELIMINARY SCHEDULE

A. Procedure:
   1. Submit proposed Preliminary Schedule within 14 calendar days after Notice to Proceed.
   2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule to review and make necessary adjustments.
   3. Submit revised Preliminary Schedule within 5 calendar days after meeting.
   4. Update Preliminary Schedule monthly until the Baseline Schedule is accepted.

B. Format:
   1. Simplified Gannt chart.

C. Activities:
   1. Define activities to be completed in the first 90 calendar days of Work.
   2. Actualize activities performed during the first 90 days into the first monthly Schedule update.

1.09 PRELIMINARY SCHEDULE OF VALUES

A. Preliminary Schedule of Values as specified in Section 01292 - Schedule of Values.

B. Procedure:
   1. Submit proposed Preliminary Schedule of Values within 14 calendar days after Notice to Proceed.
   2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule of Values to review and make necessary adjustments.
   3. Submit revised Preliminary Schedule of Values within 5 calendar days after meeting.

1.10 WORK WITHIN THE FIRST 90 DAYS

A. Proceed with Work after Preliminary Schedule and Preliminary Schedule of Values have been accepted by Owner.

B. Submittal and acceptance of Preliminary Schedule and Preliminary Schedule of Values is condition precedent to making of progress payments as specified in Section 01294 - Applications for Payment and payments for mobilization costs otherwise provided for in the Contract.

1.11 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall include Submittals required in the Contract Documents but not limited to test plans, training plans, test procedures, operation and maintenance manuals, Shop Drawings, samples, record documents, and specifically required certificates, warranties, and service agreements.

B. Preliminary Schedule of Submittals:
   1. Due date: After Preliminary Schedule has been submitted and accepted by the Owner.
   2. Format:
      a. Include Submittals anticipated in the first 90 calendar days after award of Contract using early start dates.
      b. Indicate week and month anticipated for submittal to Engineer.
      c. Indicate “Priority” Submittals where review time can impact Contractor’s schedule.
         1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” Submittals where possible.
   3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after award of Contract.

C. Final Schedule of Submittals:
   1. Due date: 30 days after Baseline Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include Submittals using early start dates.
      b. Include all Submittals, including those required in the Preliminary Schedule of Submittals.
      c. Indicate week and month anticipated for submittal to Engineer.
      d. Indicate “Priority” submittals where review time can impact Contractor’s schedule.
         1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” Submittals where possible.
   3. Submittal of final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.

D. Provide updated Schedule of Submittals with updated schedules if Schedule revisions change listing and timing of Submittals.

1.12 BASELINE PROGRESS SCHEDULE AND BASELINE SCHEDULE OF VALUES

A. Due date: No more than 45 calendar days after Notice to Proceed.

B. Format:
   1. Progress Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.
   2. Schedule of Values: As specified in Section 01292 - Schedule of Values.

C. Acceptance of the Baseline Progress Schedule and Baseline Schedule of Values by the Owner is a condition precedent to making payments as specified in Section 01294 - Applications for Payment after the first 90 calendar days after Notice to Proceed.

1.13 SUMMARY SCHEDULE

A. Due date: At weekly progress meetings and after each Schedule update or Schedule revision.

B. Format:
   1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
   2. Intended to give an overall indication of the Project Schedule without a large amount of detail.

1.14 COST FLOW SUMMARY

A. Due date: After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis as specified in Section 01294 - Applications for Payment.

B. Format:
   1. Tabular and graphic report showing anticipated earnings each month of the Contract period.
   2. Base tabulation on the summation of the cost-loaded activities each month.
   3. Show planned amounts.
   4. Show actual earned amounts and anticipated remaining earnings.
   5. Spreadsheet format of all schedule activities showing cost and percentage completion during the current month for which payment is sought.

1.15 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES

A. Due date: Submit on a monthly basis as specified in Section 01294 - Applications for Payment.

B. Format: As specified in Section 01292 - Schedule of Values.

1.16 WEEKLY SCHEDULE

A. Due date: At every weekly progress meeting.

B. Format:
   1. Contractor and Engineer must agree on the format.
   2. 6-week Schedule showing the activities completed during the previous week and the Contractor’s schedule of activities for following 5 weeks.
   3. Use the logic and conform to the status of the current Progress Schedule when producing a weekly Schedule in CPM schedule or a bar chart format.
      a. In the event that the weekly Schedule no longer conforms to the current Schedule, Contractor may be required to revise the Schedule as specified in this Section.

4. Activity designations used in the weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule updates.

1.17 LABOR HISTOGRAM

A. Due date:
   1. With progress payments after Baseline Schedule has been submitted and accepted by Owner.

B. Format:
   1. Labor histogram depicting total craft manpower and craft manpower for Contractor's own labor forces and those of each subcontractor.
   2. Submit in electronic format.

1.18 COMMISSIONING SCHEDULE

A. Commissioning activities and milestones, as specified, shall be an integral part of the overall Progress Schedule.
   1. Commissioning activities and milestones shall be extracted from the Progress Schedule to provide a separate Commissioning schedule that is submitted each time the Progress Schedule is submitted.

B. Proposed Commissioning Schedule:
   1. Schedule requirements: As specified.
   2. Submittal due date: Within 20 days after Notice to Proceed.
   3. Engineer response due within 20 calendar days of receipt.
   4. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.

C. Construction Schedule can include the Commissioning Schedule after Engineer acceptance of the Proposed Commissioning Schedule.
   1. Capable of extracting a stand-alone Commissioning Schedule.
   2. Capable of extracting a stand-alone Owner Training Schedule.

D. Monthly update requirements:
   1. Highlight percentages of completion, actual start and finish dates, and remaining durations, as applicable.
   2. Include activities not previously included in the previously accepted detail work plan Commissioning Schedule.
   3. Change Order required for any change to contractual dates.
   4. Reviews of these Submittals by Engineer will not be construed to constitute acceptance within the time frames, durations, or sequence of work for each added activity.

1.19 REVIEW AND ACCEPTANCE OF SCHEDULES

A. Engineer will review preliminary Schedules, Schedule updates, Schedule revisions, and time impact analyses to ascertain compliance with specified project constraints, compliance with milestone dates, durations and sequence, accurate inter-relationships, and completeness.

B. Engineer and Owner will issue written comments following completion of review of baseline Schedules within 21 calendar days after receipt.

C. Written comments on review of Schedule updates and Schedule revisions and time impact analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.

D. Revise and resubmit Schedules in accordance with Engineer's comments within 7 calendar days after receipt of such comments or request joint meeting to resolve objections.

E. If the Engineer requests a meeting, the Contractor and all major subcontractors shall participate.
   1. Revise and resubmit Schedule within 7 calendar days after meeting.

F. Use accepted Schedules for planning, organizing, and directing the Work and for reporting progress.

G. Engineer's Submittal review response:
   1. When Schedules reflects the Owner's and Contractor's agreement of project approach and sequence, Schedules will be accepted by the Owner.
   2. Engineer's Submittal review response for Schedule Submittals will be "Receipt Acknowledged - Filed for Record".
   3. Acceptance of the Schedules by the Owner is for general conformance with the Contract Documents and for the Owner's planning information and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the Contract completion dates.
      a. Omissions and errors in the accepted Schedules shall not excuse performance less than that required by the Contract Documents.
      b. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.20 SCHEDULE UPDATES

A. Any update:
   1. Prepare update using most recent accepted version of Schedule including:
      a. Actual start dates of activities that have been started.
      b. Actual finish dates of activities that have been completed.
      c. Percentage of completion of activities that have been started but not finished.
      d. Actual dates on which milestones were achieved.
      e. Update activities by inputting percent complete figures with actual dates.
      f. Use retained logic in preparing Schedule updates.
      g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
      h. Revisions to the Schedule may be included that have been previously approved as specified.

B. Monthly updates:
   1. Submit written narrative report in conjunction with each Schedule update, including descriptions of the following:
      a. Activities added to or deleted from the Schedule are to adhere to cost and other resource loading requirements.
         1) Identify added activities in manner distinctly different from original activity designations.
      b. Changes in sequence or estimated duration of activities.
      c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
      d. Assumptions made and activities affected by incorporating change order work into the Schedule.
      e. Include a response in writing to each of the Engineer's comments or questions from the previous month's schedule review and number responses consistent with the Engineer's numbering.
   2. Submit updated Schedule and materials specified under Submittal of Progress Schedules 5 calendar days before the monthly schedule update meeting.
   3. Since monthly Schedule update is the application for progress payment required as specified in Section 01294 - Applications for Payment, submittal and acceptance of the monthly Schedule update is a condition precedent to the making of any progress payments.

C. Weekly progress meeting:
   1. Update the Schedule prior to weekly progress meeting.
      a. Identify overall progress of each major item of work in the summary schedule.
      b. If there are significant changes to the Schedule, submit a written report at the weekly progress meeting.
   2. Should monthly Schedule update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as "Project Float".
   3. Should monthly Schedule update show Project completion later than current Contract completion date, prepare and submit a Schedule revision.

1.21 REVISIONS TO SCHEDULES

A. Submit revised Schedules within 5 days:
   1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
   2. When delays in Submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
   3. When the Schedule does not represent the actual progress of activities.
   4. When any change to the sequence of activities, the completion date for major portions of the Work, or when changes occur which affect the critical path.
   5. When Contract modification necessitates Schedule revision, submit schedule analysis of Change Order work with cost proposal.

B. Create a separate Submittal for Schedule revisions.
   1. Comply with Schedule updates as specified in this Section.
   2. Do not submit with Schedule updates.

C. Schedule revisions will not be reflected in the Schedule until after the revision is accepted by the Owner.
    1. This includes Schedule revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.22 ADJUSTMENT OF CONTRACT TIME OR PRICE

A. Contract Time will be adjusted only for causes specified in Contract Documents.

B. If the Contractor believes that the Owner has impacted its work such that the Project completion date will be delayed, the Contractor must submit proof, in the form of a time impact analysis demonstrating the delay to the critical path.

C. Time impact analysis:
    1. Use the accepted Schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the Schedule by:
        a. Inserting new activities associated with the delay event into the Schedule.
        b. Revising activity logic.
        c. Revising activity durations.
    2. If the Progress Schedule's critical path and completion date are impacted as a result of adding this delay event to the Progress Schedule, a time extension equal to the magnitude of the impact may be warranted.
    3. The time impact analysis Submittal must include the following information:
        a. A fragment of the portion of the Schedule affected by the delay event.
        b. A narrative explanation of the delay issue and how it impacted the Schedule.
        c. A schedule file used to perform the time impact analysis.

D. When a delay to the Project as a whole can be avoided by revising preferential sequencing or logic and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.

E. Indicate clearly that the Contractor has used, in full, all project float available for the Work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date.
    1. Utilize the latest version of the Schedule update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

F. Adjustment of the Contract Times will be granted only when the Contract float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date.
    1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.

G. Actual delays in activities which do not affect the Critical Path Work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.

H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to job-site or home office overhead beyond the Contractor's originally planned occupancy of the site.

I. Notify Engineer of a request for Contract Time adjustment.
   1. Submit request as specified in the Contract Documents.
   2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

J. Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing.
   1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule update.
   2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.
   3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
   4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.23 WEATHER DAY ALLOWANCE

A. Allowance:
   1. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Day Allowance".

B. Actual Weather Day:
   1. Insert a weather delay activity in the critical path to reflect actual weather day occurrences when weather days are experienced and accepted by the Engineer.
   2. Reduce duration of Weather Day Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in the Weather Day Allowance at completion of the Project is considered float.
   3. Provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted.
      a. A Schedule update will not suffice as a written notice.
      b. Engineer will determine if the Weather Day constitutes a use of a portion of the Weather Day Allowance.
      c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.

1.24 ALLOWANCE FOR OWNER-CAUSED DELAY

A. Allowance:
   1. Include as a separate identifiable activity on the critical path, an activity labeled “Allowance for Owner-Caused Delay.”
   2. Insert this activity at the end of the Schedule, following the Project Completion Milestone.
   3. Duration of this activity is specified in the Bid Form.
      a. The duration of this Owner-Caused Delay Allowance is in addition to the contractual time frame.

B. Actual delay:
   1. Insert an activity in critical path to reflect actual Owner-caused delay occurrences when Owner-Caused delay days are experienced and accepted by Engineer.
      a. Identify this activity as an Owner-Caused delay.
   2. Reduce duration of Owner-Caused Delay Allowance activity as Owner-caused delays are experienced and inserted into the Schedule. Remaining days in Owner-Caused Delay Allowance at completion of project is considered float.

1.25 FINAL SCHEDULE

A. The final Schedule update becomes the As-Built Schedule.
   1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.
   2. Contractor’s Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.

B. Retainage will not be released until final Schedule update is provided.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements and procedures for Submittals to confirm compliance with Contract Documents.

1.02 GENERAL INSTRUCTIONS

A. Contractor is responsible to determine and verify field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved Shop Drawings and Contract Document requirements.

B. Provide Submittals:
   1. That are specified or reasonably required for construction, operation, and maintenance of the Work.
   2. That demonstrate compliance with the Contract Documents.

C. Where multiple Submittals are required, provide a separate Submittal for each Specification section.
   1. In order to expedite construction, the Contractor may make more than one Submittal per Specification section, but a single Submittal may not cover more than one Specification section:
      a. The only exception to this requirement is when one Specification section covers the requirements for a component of equipment specified in another section.
      b. For example, circuit breakers are a component of switchgear. The switchgear Submittal must also contain data for the associated circuit breakers, even though they are covered in a different Specification section.

D. Prepare Submittals in the English language. Do not include information in other languages.

E. Present measurements in customary American units (feet, inches, pounds, etc.).

F. Must be clear and legible, and of sufficient size for presentation of information.

G. Page size, other than drawings:
   1. Minimum: 8-1/2 inches by 11 inches.
   2. Maximum: 11 inches by 17 inches.

H. Drawing sheet size:
   1. Maximum: 22 inches by 34 inches.
      a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8-inch.
   2. 11-inch by 17-inch sheet:
      a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8-inch.

I. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.

J. Provide Submittal information from only one manufacturer for a specified product. Submittals with multiple manufacturers for one product will be rejected without review.

1.03 SUBMITTAL ORGANIZATION

A. Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.

B. For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is used.

C. Bookmarks:
   1. Bookmarks shall match the table of contents.
   2. Bookmark each section (tab) and heading.
   3. Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
   4. At file opening, display all levels of bookmarks as expanded.

D. Where applicable (i.e., except for Drawings, figures, etc.), Submittal content shall be electronically searchable utilizing the PDF file as submitted.

E. Thumbnails optimized for fast web viewing.

F. Sequentially number pages within the tabbed sections:
   1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.

G. Attachments:
   1. Include with each Submittal a copy of the relevant Specification section.
      a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
   2. Include with each Submittal a copy of the relevant Drawing, including relevant addendum updates.
      a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).

b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

H. Contractor: Prepare Submittal information in sufficient detail to show compliance with specified requirements.
1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
2. Coordinate Submittal with other Submittals and with the requirements of the Contract Documents.
3. Check, verify, and revise Submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

I. Contractor: Prepare “Or Equal” Submittal information.
1. Provide standard Submittal requirements.
a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
2. Provide reason the specified product is not being provided.
3. Explain the benefits to the Owner for accepting the “Or Equal”.
4. Itemized comparison of the proposed “Or Equal” with product specified, including a list of significant variations:
a. Design features.
b. Design dimensions.
c. Installation requirements.
d. Operations and maintenance requirements.
e. Availability of maintenance services and sources of replacement materials.
5. Reference projects where the product has been successfully used:
a. Name and address of project.
b. Year of installation.
c. Year placed in operation.
d. Name of product installed.
e. Point of contact: Name and phone number.
6. Define impacts:
a. Impacts to other contracts.
b. Impacts to other work or products.
7. Contractor represents the following:
a. Contractor bears the burden of proof of the equivalency of the proposed “Or Equal”.
b. Proposed “Or Equal” is equal or superior to the specified product.
c. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed “Or Equal”, unless the Owner requires a Special Warranty.
d. Contractor will coordinate installation of accepted “Or Equal” into the Work and will be responsible for the costs to make changes as required to the Work.
e. Contractor waives rights to claim additional costs caused by proposed “Or Equal” which may subsequently become apparent.

J. Contractor: Prepare substitution Submittal information.
   1. Provide standard Submittal requirements.
      a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
   2. Provide reason the specified product is not being provided.
   3. Explain the benefits to the Owner for accepting the substitution.
   4. Itemized comparison of the proposed substitution with product specified, including a list of significant variations:
      a. Design features.
      b. Design dimensions.
      c. Installation requirements.
      d. Operations and maintenance requirements.
      e. Availability of maintenance services and sources of replacement materials.
   5. Reference projects where the product has been successfully used:
      a. Name and address of project.
      b. Year of installation.
      c. Year placed in operation.
      d. Name of product installed.
      e. Point of contact: Name and phone number.
   6. Define impacts:
      a. Impacts to Contract Price.
         1) Required license fees or royalties.
         2) Do not include costs under separate contracts.
         3) Do not include Engineer's costs for redesign or revision of Contract Documents.
      b. Impacts to Contract Time.
      c. Impacts to Contract Scope.
      d. Impacts to other contracts.
      e. Impacts to other work or products.
   7. Contractor represents the following:
      a. Contractor shall pay associated costs for the Engineer to evaluate the substitution.
      b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
      c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
      d. Proposed substitution is equal or superior to the specified product.
      e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless the Owner requires a Special Warranty.
      f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
      g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

1.04 SUBMITTAL IDENTIFICATION NUMBERING

A. Number each Submittal using a sequential numbering sequence. All Submittals must be assigned to a Specification section.

B. Number each Submittal using the format defined in the table below:

	Spec Section Number	Dash	Initial Submittal - Sequential Number	Decimal Point	Subsequent Submittal Revisions Sequential Number
Example 1 Description	*Cast-In-Place Concrete*		*8th initial Submittal*		
	03300	-	0008		
Example 2 Description	*Cast-In-Place Concrete*		*8th initial Submittal*		*First revision to the 8th initial Submittal*
	03300	-	0008	.	1

1.05 SUBMITTALS IN ELECTRONIC MEDIA FORMAT

A. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.

B. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).

C. Graphics: Provide graphic Submittals (Drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

1.06 SUBMITTAL PROCEDURE

A. Engineer: Review Submittal and provide response:
   1. Review description:
      a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular Submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
      b. Engineer's review of Submittals shall not release the Contractor from the Contractor's responsibility for performance of requirements of Contract Documents. Neither shall the Engineer's review release the Contractor from fulfilling purpose of installation nor from the Contractor's liability to replace defective Work.
      c. Engineer's review of Shop Drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
      d. Engineer's review does not extend to:
         1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by the Contractor.
         2) Contractor's means, methods, techniques, sequences, or procedures, except when specified, indicated on the Drawings, or required by Contract Documents.
         3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.

e. Engineer can Approve or Not Approve any exception at their sole discretion.

2. Review timeframe:
   a. Except as may be provided in technical Specifications, a Submittal will be returned within 30 days.
   b. When a Submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the Submittal, give notice of the date by which that Submittal will be returned.
   c. Engineer's acceptance of progress schedule containing Submittal review times less than those specified or agreed to in writing by the Engineer will not constitute Engineer's acceptance of review times.
   d. Critical Submittals:
      1) Contractor will notify Engineer in writing that timely review of a Submittal is critical to the progress of Work.
3. Schedule delays:
   a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of Submittals unless all of the following criteria are met:
      1) Engineer has failed to review and return first submission within the agreed upon time frame.
      2) Contractor demonstrates that delay in progress of Work is directly attributable to the Engineer's failure to return Submittal within time indicated and accepted by the Engineer.
4. Review response will be returned to the Contractor with one of the following dispositions:
   a. Approved:
      1) No Exceptions:
         a) There are no notations or comments on the Submittal and the Contractor may release the equipment for production.
      2) Make Corrections Noted - See Comments:
         a) Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Resubmittal not required.
      3) Make Corrections Noted - Confirm:
         a) Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
   b. Not Approved:
      1) Correct and Resubmit:
         a) Contractor may not proceed with the Work described in the Submittal.
         b) Contractor assumes responsibility for proceeding without approval.
         c) Resubmittal of complete Submittal package is required within 30 calendar days of the date of the Engineer's Submittal review response.
      2) Rejected - See Remarks:
         a) Contractor may not proceed with the Work described in the Submittal.

b) Submittal does not meet the intent of the Contract Documents. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

c. Receipt Acknowledged:
   1) Filed for Record:
      a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.
   2) With Comments - Resubmit:
      a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.

B. Contractor: Prepare resubmittal, if applicable:
   1. Clearly identify each correction or change made. Provide page references to the changed information within the resubmittal.
   2. Include a response in writing to each of the Engineer's comments or questions for Submittal packages that are resubmitted in the order that the comments or questions were presented from the first and subsequent Submittals and numbered consistent with the Engineer's numbering.
      a. Acceptable responses to the Engineer's comments are listed below:
         1) "Incorporated" - Engineer's comment or change is accepted and appropriate changes are made.
         2) "Response" - Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by the Engineer.
      b. Reviews and resubmittals:
         1) Contractor shall provide resubmittals which include responses to all Submittal review comments separately and at a level of detail commensurate with each comment.
         2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment.
            a) Responses such as "acknowledged" or "noted" are not acceptable.
         3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
         4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant Submittals.
         5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.

c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for revision and resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Resubmittal timeframe:
   a. Contractor shall provide resubmittal within 15 days.
   b. When a resubmittal cannot be returned within the specified period, Contractor shall notify the Engineer in writing.
4. Review costs:
   a. Costs incurred by the Owner as a result of additional reviews of a particular Submittal after the second time it has been reviewed shall be borne by the Contractor.
   b. Reimbursement to the Owner will be made by deducting such costs from the Contractor's subsequent progress payments.

1.07 PRODUCT DATA

A. Edit Submittals so that the Submittal specifically applies to only the product furnished.

B. Neatly cross out all extraneous text, options, models, etc., that do not apply to the product being furnished so that the information remaining is only applicable to the product being furnished.

1.08 SHOP DRAWINGS

A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of Shop Drawings.

B. Indicate project-designated equipment tag numbers for Submittal of devices, equipment, and assemblies.

1.09 SAMPLES

A. Details:
   1. Submit labeled samples.
   2. Samples will not be returned.
   3. Provide number of sample Submittals as below:
      a. Total: 3 minimum.
         1) Owner: 1.
         2) Engineer: 2.
         3) Contractor: None.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - CONTRACTOR SUBMITTAL TRANSMITTAL FORM

CONTRACTOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY
Contractor:	Click here to enter text.	**Project No.:**	XXXXX.XX
Project Name:	Click here to enter text.	**Submittal Number:**	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal/Equipment Supplier			
Spec ##:	Spec ##.	**Subject:**	Click here to enter text.
Authored By:	Click here to enter text.	**Date Submitted:**	XX/XX/XXXX

Submittal Certification		
Check Either (A) or (B):		
☐	(A)	We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings with no exceptions.
☐	(B)	We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings, except for the deviations listed.
Certification Statement: By this Submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved Shop Drawings and all Contract requirements.		
General Contractor's Reviewer's Signature:		
Printed Name:		

PM/CM Office Use	
Date Received GC to PM/CM:	
Date Received PM/CM to Reviewer:	
Date Received Reviewer to PM/CM:	
Date Sent PM/CM to GC:	

SECTION 01357

DELEGATED DESIGN PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Delegated Design procedures.

1.02 GENERAL

A. Delegated Design - Professional design services assigned to the Contractor by express delegation in the Contract Documents. Work is “Delegated Design” where the Technical Sections require the Contractor to provide professional design services and to submit signed and sealed documents from a registered Professional Engineer.

B. Contractor’s Professional Engineer - The design professional retained by the Contractor to perform Delegated Design.

C. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents.
   1. Requirements of Delegated Design component as specified in the Technical Section and as indicated on the Drawings.
   2. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that the Contractor must furnish to the Engineer with respect to the Delegated Design.

D. Contractor shall cause such Delegated Design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal shall appear on Drawings, calculations, Specifications, certifications, and Submittals prepared by such design professional.
   1. Contractor shall not be responsible for the adequacy of performance or design criteria specified by the Owner or Engineer.
   2. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.
   3. Such design professional shall issue certifications of design required by Laws and Regulations.
   4. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by the Contractor, a Subcontractor, or others for submittal to the Engineer, then such Shop Drawing or other Submittal shall bear the written approval of Contractor’s design professional when submitted by the Contractor to the Engineer.

E. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under Delegated Design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

F. Engineer's review, approval, and other determinations regarding design drawings, calculations, Specifications, certifications, and other Submittals furnished by Contractor pursuant to a Delegated Design will be only for the following limited purposes:
   1. Confirming that Submittal is in conformance with the performance and design criteria specified in the Contract Documents.

1.03 CONTRACTOR'S PROFESSIONAL ENGINEER

A. Contractor or Subcontractor shall retain a licensed Professional Engineer to perform Delegated Design.

B. Qualifications:
   1. Holding a current license to perform the specified design in the same jurisdiction as the Project Site.
   2. Experienced in designing similar systems of similar complexity.

C. Insurance:
   1. Provide Contractor's Professional Engineer's Professional Liability Insurance.

D. Responsibilities:
   1. Review and design in accordance with system performance and design criteria stated in the Contract Documents.
      a. Prepare written requests for clarifications or interpretations of performance or design criteria for submittal to the Engineer by the Contractor.
   2. Sign and seal design reports, calculations, design drawings and specifications, and other design Submittals for the Delegated Design Work.
   3. Review and submit written approval of Submittals related to the Delegated Design Work.
   4. Design modifications to the Delegated Design Work as required.
   5. Visit the Site, as required, to verify that installation of the Delegated Design Work is in conformance with the Delegated Design Drawings and Specifications.
   6. Submit through Contractor to Engineer written, signed, and sealed certification that the installed Delegated Design Work complies with Contractor's Professional Engineer's design.

1.04 SUBMITTALS

A. Prior to the start of Delegated Design:
   1. Contractor's Professional Engineer's qualifications:
      a. Experience for the Delegated Design.
      b. Evidence of Professional Engineering license.
   2. Contractor's Professional Engineer Professional Liability Insurance certificate.

B. Delegated Design:
   1. Product data:
      a. Details related to the Delegated Design as specified in Technical Sections to completely describe the system.
   2. Design documents with signature and seal from the Contractor's Professional Engineer.
      a. Design documents include, but are not limited to, Drawings, calculations, Specifications, inspection reports, and certifications.
   3. Lists and schedules:
      a. Prepare and submit lists or schedules of items where Delegated Design is required by the Contract Documents.
      b. Group items by location in the Work.
         1) When "Area Numbers" are indicated on the Contract Drawings, group lists in accordance with those "areas."
         2) For work without area numbers, group using logical divisions acceptable to the Engineer.
         3) Group items within each "area" as follows:
            a) Systems.
            b) Components.
            c) Supports.
            d) Anchorage.
            e) Bracing.

C. Construction services:
   1. Contractor's Professional Engineer's comments on Submittals.
   2. Other construction documents, as required.

1.05 ENGINEER RESPONSE TO DELEGATED DESIGN SUBMITTALS

A. Engineer response will be either of the following:
   1. Approved. Make Corrections Noted - See Comments:
      a. Contractor may proceed with the Work; however, all notations and comments must be incorporated into the final product.
      b. Review was for the limited purpose of determining that the document was stamped by a Professional Engineer and that such design is generally consistent with and will not negatively affect the design concept presented in the Contract Documents.
   2. Rejected - See Remarks:
      a. Contractor may not proceed with the Work described in the Submittal.
      b. Submittal does not meet the intent of the Contract Documents.
      c. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01410

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Regulatory authorities and codes.

1.02 AUTHORITIES HAVING JURISDICTION (AHJ)

A. Also referred to as the permitting agency.

B. Building Department.

C. Fire Department.

D. Florida Department of Environmental Protection.

1.03 APPLICABLE CODES

A. Products in contact with drinking water
   1. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.
      a. Certification by an independent ANSI accredited third party, including, but not limited to, NSF International, as being lead free.

B. Florida Building Commission (FBC):
   1. Building code:
      a. Florida Building Code, 8th Edition, 2023.

C. Florida Fire Prevention Code (FFPC):
   1. Fire Code:
      a. Florida Fire Prevention Code, 8th Edition, 2023.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Quality control and control of installation.
   2. Tolerances.
   3. References.
   4. Mock-up requirements.
   5. Authority and duties of Owner's representative or inspector.
   6. Sampling and testing.
   7. Testing and inspection services.
   8. Contractor's responsibilities.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H. When specified, products will be tested and inspected either at point of origin or at Work site:
   1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.

I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

A. ASTM International (ASTM):
   1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

B. National Institute of Standards and Technology (NIST).

1.05 PRODUCT REQUIREMENTS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.06 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.07 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. Owner’s Project Representative employed or retained by Owner is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.

D. Inspector will not:
   1. Alter or waive provisions of Contract Documents.
   2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
   3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.

E. Inspector will:
   1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
   2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.08 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
      b. Test materials in accordance with standards of national technical organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
   4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

1.09 TESTING AND INSPECTION SERVICES

A. Contractor will employ and pay for specified services of an independent firm to perform Contractor quality control testing as required in the technical specifications for various work and materials.

B. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
   1. Has authorization to operate in the state where the project is located.
   2. Meets “Recommended Requirements for Independent Laboratory Qualification,” published by American Council of Independent Laboratories.
   3. Meets requirements of ASTM E329.
   4. Laboratory Staff: Maintain full time specialist on staff to review services.
   5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to NIST or accepted values of natural physical constants.
   6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NIST during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.

C. Testing, inspections, and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.

1.10 CONTRACTOR'S RESPONSIBILITIES

A. Secure and deliver to Owner’s independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

B. Provide to Owner’s independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

C. Submit product test reports electronically.

D. Furnish incidental labor and facilities:
   1. To provide access to construction to be tested.
   2. To obtain and handle samples at Work site or at source of product to be tested.
   3. To facilitate inspections and tests.
   4. For storage and curing of test samples.
   5. For shipping or delivery of samples.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

1.02 REFERENCE

A. American National Standards Institute (ANSI).

B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

1.04 TEMPORARY UTILITIES

A. Temporary electrical power:
   1. Owner provides the power.
      a. The Contractor is responsible for providing breakers, switches, transformers, and cables required to obtain temporary power.
      b. The Owner will pay charges for construction power obtained from these locations.
   2. Contactor shall provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.

B. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
   2. When available, permanent lighting facilities may be used in lieu of temporary facilities:

C. Temporary heating, cooling, and ventilating:
   1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
   2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

D. Temporary water:
   1. The Owner will supply water used for construction.

E. Temporary sanitary facilities:
   1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
   2. Existing facility use is not allowed.
   3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

F. Temporary fire protection:
   1. Provide fire protection required to protect the Work and ancillary facilities.

G. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

H. Utilities in existing facilities: As specified in Section 01140 - Work Restrictions.

I. Temporary piping systems:
   1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
   2. Submit product data for piping, fittings, appurtenances, restraints, supports, and other components of the temporary piping system.
   3. Submit information at least 28 days prior to when each temporary piping system is scheduled to be installed and allow 14 days for review and comment.

J. Temporary pumping systems:
   1. Submit pump data, performance curves, and other operating information.
   2. Submit sketches showing layout of temporary pumping system, including pump quantity, configuration in wet well, and proposed piping layout specified in this Section.
   3. Submit piping headloss calculations based on proposed temporary piping system layout.
   4. Submit information at least 28 days prior to when the temporary pumping system is scheduled to be installed and allow 14 days for review and comment.

1.05 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
   1. Provide devices in accordance with minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

F. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

1.06 SECURITY

A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.07 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. Comply with noise and work hours regulations by local jurisdiction.
   2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
   3. In residential areas, take special measures to suppress noise during night hours.

1.08 CONTRACTOR FIELD OFFICES AND SHEDS

A. The Contractor has the option to maintain a field office on the Project Site, in a location designated by the Engineer.

B. Connection of temporary utilities for the Contractor’s field office will be paid for by the Contractor.

1.09 SITE RESTORATION

A. Restore disturbed areas of the site.

B. Staging areas shall be regraded if necessary and resodded with St. Augustine sod.

1.10 REMOVAL

A. Remove temporary facilities and controls before inspection for final Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for products.

1.02 TERMINOLOGY

A. The words and terms listed below, are not defined terms that require initial capital letters, but, when this Section is referenced in other Specifications, have the indicated meaning.
   1. Manufacturer's instructions:
      a. Stipulations, directions, and/or recommendations issued by the manufacturer of the product addressing handling, storage, installation, protection, erection, and/or application of the product.
   2. Product data:
      a. Information about the product, typically found in the manufacturer's catalogs specifications or other resources, including data sheets, bulletins, and brochures.
   3. Spare parts and maintenance products:
      a. Duplicate parts necessary to replace a damaged or worn part of the product.
      b. Consumables such as operating fluids.
   4. Special tools:
      a. Special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a product that would not normally be in the Owner's tool kit and that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.

1.03 SHIPMENT

A. Requirements prior to shipment of equipment:
   1. Engineer approved Submittals or other written documentation allowed by the Contract Documents.
   2. Engineer approved Manufacturer's Certificate of Source Testing.
   3. Operations and maintenance manuals as specified in Section 01782 - Operation and Maintenance Manuals and the Technical Sections.

B. Transport products by methods that avoid product damage.

C. Deliver products in undamaged condition in the manufacturer's unopened packaging.

1.04 DELIVERY AND HANDLING

A. Handle products in accordance with the manufacturer's instructions.

B. Deliver products in undamaged condition in the manufacturer's unopened packaging.

C. Provide construction equipment and personnel to handle products by methods in accordance with the manufacturer's instructions.

D. Upon delivery, promptly inspect shipments:
   1. Verify compliance with the Contract Documents, correct quantities, and undamaged condition of products.
   2. Acceptance of shipment does not constitute final acceptance of products.

E. Owner may request advanced delivery of spare parts, maintenance products, and special tools.
   1. Deduct the delivered items from the inventory list and provide transmittal documentation.

1.05 STORAGE

A. Immediately store and protect products until installed in the Work.

B. Store products with seals and legible labels intact.

C. Protect painted or coated surfaces against impact, abrasion, discoloration, and damage.

D. Storage of equipment in accordance with the manufacturer's instructions.
   1. Including connection of motor heaters, lubrication, manually rotating shafts, etc.
   2. Furnish a copy of the manufacturer's instructions for storage to the Engineer prior to storage of equipment and materials.

E. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for mechanical equipment, valves, architectural items, electrical and instrumentation equipment.

F. Storage of spare parts, maintenance products, special tools.
   1. Immediately store in accordance with the manufacturer's instructions.
   2. Store spare parts, maintenance products, and special tools in an enclosed, weather-proof, and lighted facility during the construction period.
   3. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
   4. Store large items individually:
      a. Weight: Greater than 50 pounds.
      b. Size: Greater than 24-inches wide by 18-inches high by 36-inches long.
      c. Clearly labeled:
         1) Equipment tag number.
         2) Equipment manufacturer.
         3) Subassembly component, if appropriate.

5. Store smaller items in spare parts boxes:
    a. Weight: Less than 50 pounds.
    b. Size: Less than 24-inches wide by 18-inches high by 36-inches long.
    c. Clearly labeled:
        1) Equipment tag number.
        2) Equipment manufacturer.
        3) Subassembly component, if appropriate.
6. Spare parts and special tools box:
    a. Box material: Waterproof, corrosion resistant.
    b. Hinged cover with locking hasp:
        1) Inventory list taped to underside of cover.
        2) Clearly labeled:
            a) “Spare Parts and/or Special Tools”.
            b) Equipment tag number.
            c) Equipment manufacturer.
            d) Subassembly component, if appropriate.

G. Exterior storage of fabricated products:
    1. Place on aboveground supports that allow for drainage.
    2. Cover products subject to deterioration with impervious sheet covering.
    3. Provide ventilation to prevent condensation under covering.

H. Store moisture sensitive products in watertight enclosures.

I. Store loose granular materials on solid surfaces in well-drained area.
    1. Prevent materials mixing with foreign matter.
    2. Provide access for inspection.

J. Provide an equipment log and stored products log with monthly pay applications.
    1. Include: Storage location, equipment or product identification, date stored, date of inspection/maintenance, date removed from storage, copy of manufacturer’s recommended storage guidelines, description of inspection/maintenance activities performed, and signature of party performing inspection/maintenance.

K. When needed and approved by the Engineer, offsite storage location shall be within 20 miles of the Project Site.
    1. Provide proof of insurance coverage for products stored offsite.

L. Payment will not be made for products improperly stored or stored without providing the Engineer with the manufacturer’s instructions for storage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide products by the same manufacturer when units are of similar nature, unless otherwise specified.

B. Provide like parts of duplicate units that are interchangeable.

C. Provide equipment or products that have not been in service prior to delivery, except as required by tests.

D. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
   1. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

E. Provide products produced by manufacturers regularly engaged in the production of these products.

F. Provide products that bear approvals and labels as specified such as Factory Mutual (FM), Underwriters Laboratory (UL), or National Sanitation Foundation (NSF International) that are acceptable to the Authority Having Jurisdiction.

A. All wetted materials used in the production of potable water, or in contact with the water or chemicals used to treat water, shall conform to NSF 60/61 or other acceptable standards in accordance with Florida Administrative Code 62-555 - Permitting, Construction, Operation And Maintenance of Public Water Systems.

2.02 MATERIAL

A. Dissimilar metals:
   1. Separate contacting surfaces with dielectric material.
   2. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, washers, petrolatum tape, or other materials as specified.
   3. Dielectric coatings can be used to separate dissimilar metal couples from surrounding environment if isolation of metals is not possible, with approval of the Engineer.

B. Edge grinding:
   1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence and mitigate any safety hazard.
   2. A surface profile will need to be re-established for coating adherence based on coating manufacturer’s profile requirements.

C. Use anti-galling compound on threads of stainless steel fasteners during factory assembly.

D. Provide anti-galling compound with stainless steel fasteners shipped for field assembly.

2.03 PRODUCT SELECTION

A. When products are specified without named manufacturers, provide products that meet or exceed the Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide products by one of the named manufacturers that meet or exceed specifications.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide products with model numbers or catalog designations by one of the named manufacturers.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by another named manufacturer proven, in accordance with requirements for an “or equal”, including the Engineer’s approval, to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.

E. When products are specified with only one manufacturer followed by “or equal,” provide:
   1. Products meeting or exceeding specifications by specified manufacturer.
   2. Engineer deemed “or equal” evidenced by an approved Shop Drawing or other written communication.

F. When products are specified by naming 2 or more manufacturers with 1 manufacturer as a “Basis of Design”:
   1. Any of the named manufacturers can be submitted.
   2. If the product submitted is not by the named “Basis of Design” product and requires a change in the scope (dimensions, configuration, physical properties, etc.), schedule (longer lead time), or budget, the Contractor must submit a substitution request.

2.04 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. Provide spare parts and maintenance products as required by Technical Sections.
   1. Submit completed Attachment A - Spare Parts, Maintenance Products, and Special Tools Inventory List.

B. Provide 1 set of special tools required to install or service the equipment.

C. Prior to Substantial Completion, arrange to deliver spare parts, maintenance products, and special tools to the Owner at a location on site, chosen by the Owner.
   1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
   2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

D. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by the Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Inspect equipment or products prior to installation.

B. Repaint or recoat damaged painted or coated surfaces after installation.

C. Use anti-galling compound on stainless steel threads used for field assembly.

3.02 PROTECTION AFTER INSTALLATION

A. Provide coverings as necessary to protect installed products from damage due to traffic and subsequent construction operations.
   1. Remove covering when no longer needed.
   2. Replace corroded, damaged, or deteriorated products before acceptance of the Project.

B. Update equipment log with monthly pay applications.
   1. Data includes as a minimum: Description of maintenance activities performed in accordance with the manufacturer's recommendation and industry standards and signature of party performing maintenance.

END OF SECTION

ATTACHMENT A - SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

Inventory List				
Spec Number: _____		Spec Title: _____		
Equipment Tag No.: _____		Equipment Manufacturer: _____		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**

SECTION 01757

DISINFECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cleaning and disinfection requirements for new and existing facilities affected by the Work.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C651 - Disinfecting Water Mains.
   2. C652 - Disinfection of Water Storage Facilities.
   3. C653 - Disinfection of Water Treatment Plants.
   4. C655 - Field Dechlorination.

B. U.S. Environmental Protection Agency (EPA):
   1. Safe Drinking Water Act (SDWA).

1.03 SUBMITTALS

A. Submit disinfection test plan, which details procedure to be utilized to disinfect the facilities, including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of flushing and location of flushing ports (as appropriate for method of chlorination).
   4. Method of dechlorination (as appropriate for method of chlorination).
   5. Disposal location for chlorinated water (as appropriate for method of chlorination).

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Treatment subcontractor’s name, address, and phone number.
   4. Type and form of disinfectant used.
   5. Time and date of disinfectant injection start.
   6. Time and date of disinfectant injection completion.
   7. Test locations.
   8. Initial and 24-hour disinfectant residuals in milligrams per liter for each outlet tested.
   9. Time and date of flushing start.
   10. Time and date of flushing completion.
   11. Disinfectant residual after flushing in milligrams per liter for each outlet tested.

C. Submit bacteriological reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Laboratory name, certification number, address, and phone number.
   4. Time and date of water sample collection.
   5. Name of person collecting samples.
   6. Test locations.
   7. Time and date of laboratory test start.
   8. Coliform bacteria test results for each outlet tested.
   9. Certification that water conforms or fails to conform to bacterial standards of the SDWA.
   10. Bacteriologist's signature and bacteriological laboratory's evidence of certification.

D. Submit required permits, including, but not limited to, permit clearance.
   1. Coordinate with the Owner and Engineer to obtain any necessary signatures.

1.04 QUALITY ASSURANCE

A. Bacteriological and physical chemistry laboratory: Certified by the state in which the Project is located.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect chlorine and bacteriological samples against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 degrees Fahrenheit and 80 degrees Fahrenheit.

1.06 PROTECTION

A. Provide necessary signs, barricades, and notices to prevent persons from accidentally consuming water or disturbing system being treated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disinfectant: Free chlorine in liquid, powder, tablet, or gas form in accordance with AWWA C653.

B. Dechlorination agent: Sulfur dioxide, sodium bisulfate, sodium sulfite, or sodium thiosulfate, in accordance with AWWA C655.

PART 3 EXECUTION

3.01 DISINFECTION OF WATER TREATMENT PLANTS

A. Perform disinfection of water treatment plants in accordance with AWWA C653 and as specified in this Section.

B. Complete hydrostatic/leakage tests prior to disinfection.

C. Clean newly constructed and/or modified facilities, including filters and conveyance facilities, such as pipes and channels at the plant, in accordance with AWWA C653 and the following:
   1. Remove debris and material not associated with the structure or process prior to disinfection.
   2. Clean wall, floor, ceiling, and attached surfaces by use of high-pressure water jet, sweeping, scrubbing, or equally effective means.
   3. Remove water, paint flakes, sediment, dirt, and foreign material accumulated during cleaning.
   4. Remove by flushing or other means, soil and debris from water pipes and channels in accordance with AWWA C651.
   5. Protect surfaces from adverse environmental exposure between the preliminary cleaning and the disinfection stages.

D. Prior to chlorination, clean newly constructed and/or modified facilities to be disinfected in accordance with AWWA C651, C652, or C653, as applicable.

E. Provide necessary blind flanges, hoses, sample taps, or any other appurtenances that may be required to clean and disinfect the piping and wetted surfaces.

F. System treatment:
   1. Start disinfection when conditions are satisfactory.
   2. Perform disinfection of water lines and structures in accordance with AWWA C651, C652, and C653, and as specified in this Section.
   3. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.
   4. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:
      a. Ends of piping runs.
      b. Remote outlets.
      c. At least 2 outlets on each building floor where directed.
      d. Drain lines.
      e. Filters and effluent channels and piping.
   5. Maintain disinfectant in system for appropriate 6-hour or 24-hour interval in accordance with AWWA C652.
   6. When disinfectant residual is less than 10 milligrams per liter after 24 hours, repeat system treatment.

7. Stainless steel piping:
    a. Modify procedures for disinfection of stainless steel piping and appurtenances as necessary to avoid causing corrosion, pitting, or attack of stainless steel materials.
        1) Take steps to eliminate chlorinated water trapped in crevices and under gaskets through the following procedures:
            a) Pressurize stainless steel piping systems so that gaskets and O-rings are seated before introducing chlorinated water into the system.
            b) Flush to displace a minimum of 3 pipe volumes at the conclusion of the disinfection procedure.
    b. Use the continuous-feed method to fill the stainless steel piping system with the minimum chlorine concentration required to provide a 10 milligrams per liter residual after 24 hours of contact time in accordance with AWWA C651.

3.02 SURFACES TO BE DISINFECTED

A. Disinfect the following:
    1. Piping systems that are used to convey water, solutions, or chemicals to potable water facilities.

3.03 DISINFECTION OF WATER MAINS

A. Perform disinfection in accordance with AWWA C651 and as specified in this Section.

B. Cleaning:
    1. Remove, by flushing or other means, soil and debris from the water tanks in accordance with AWWA C652 prior to chlorination.

C. Inspection:
    1. Verify that water system is completed and cleaned of soil and debris prior to chlorination.

3.04 REPAIRS OR CONNECTIONS TO EXISTING LINES

A. Perform disinfection in accordance with AWWA C651 and as specified in this Section.

B. Clean and sterilize the interior surfaces of new piping, fittings, equipment, and appurtenances to be installed in an existing potable water system or connected to an existing system.

C. Clean and sterilize the existing pipe or facilities for a minimum distance of 3 pipe diameters back from the ends of the pipe. Plug the ends of the line when work is not being performed on the pipe.

D. Perform sterilization by swabbing each item with a concentrated chlorine solution.
    1. Each piece is to be disinfected prior to being assembled for installation in the existing pipe.
    2. Disinfect each piece just prior to assembly to help prevent recontamination.
    3. Plug the ends of the assembly until a new item is to be added to the assembly.

4. Store disinfected materials on blocks to prevent contact with the ground.

3.05 FLUSHING

A. Remove disinfection water from the facilities as appropriate for the type of disinfectant and method used for disinfection.

B. Flush facilities with potable water containing no more disinfectant residual than the active distribution system or 1 milligram per liter, whichever is greater, as appropriate for method of chlorination.

C. Continue flushing until water at designated flushing ports contains disinfectant residual equal to concentration specified above.

3.06 DISPOSAL OF CHLORINATED WATER

A. Dispose in accordance with AWWA C655 and as specified in this Section.

B. Dispose of chlorinated water in accordance with the submitted disinfection test plan and applicable requirements of federal, state, county, and city having jurisdiction over disposal of hazardous wastes in the location of the Project and disposal site.

C. Chlorinated water may only be disposed of in a sanitary sewer system with the written permission of the Owner. If allowed, discharge the chlorinated water at a low rate so it does not surcharge the sewer line.

3.07 BACTERIOLOGICAL TEST

A. Instruct bacteriological laboratory to collect water samples no sooner than 24 hours after start of disinfection of each facility.

B. For water mains, collect 2 sets of samples for testing for total coliform in accordance with AWWA C651 as outlined below:
   1. Option A: Before approving a main for release, take an initial set of samples and then resample again after a minimum of 16 hours using the sampling site procedures outlined.
      a. Both sets of samples must pass for the main to be approved for release.
   2. Option B: Before approving a main for release, let it sit for a minimum of 16 hours without any water use. Then collect, using the sampling site procedures outlined and without flushing the main, 2 sets of samples a minimum of 15 minutes apart while the sampling taps are left running.
      a. Both sets of samples must pass for the main to be approved for release.

C. Collect bacteriological quality samples at each of the following locations and other locations in accordance with the submitted disinfection test plan and Standard Methods for the Examination of Water and Wastewater:
   1. Where water enters system.
   2. Inlet piping.
   3. Ends of piping runs.
   4. Drain lines.
   5. Remote outlets.

6. Tanks.
7. At least 2 outlets on each building floor.

D. Analyze water samples in accordance with Standard Methods for Examination of Water and Wastewater.

E. When bacteriological test proves water quality to be unacceptable, repeat disinfection treatment process until water meets quality standards for disinfection.

END OF SECTION

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contract closeout requirements.

1.02 REFERENCES

A. American Water Works Association (AWWA).

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Substantial Completion.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Clean roofs, gutters, downspouts, and drainage systems.

F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

G. Remove dust, cobwebs, and traces of insects and dirt.

H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

I. Remove non-permanent protection and labels.

J. Polish waxed woodwork and finish hardware.

K. Wash tile.

L. Wax and buff hard floors, as applicable.

M. Wash and polish glass, inside and outside.

N. Wash and shine mirrors.

O. Polish glossy surfaces to clear shine.

P. Vacuum carpeted and soft surfaces.

Q. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.

R. Clean ducts, blowers, and coils when units were operated without filters during construction.

S. Clean light fixtures and replace burned-out or dim lamps.

T. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from the Owner of such property.

B. Do not fill ditches, washes, or drainage ways which may create drainage problems.

C. Do not create unsightly or unsanitary nuisances during disposal operations.

D. Maintain disposal site in safe condition and good appearance.

E. Complete leveling and cleanup prior to final completion of the Work.

1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Substantial Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF POTABLE WATER MAINS

A. Clean interior of pipe and fittings.

B. When pipe contains dirt that cannot be removed by flushing, swab pipe interiors with solution containing not less than 500 parts per million of chlorine until clean.

C. Flush 12-inch diameter and smaller pipe as thoroughly as available water sources will permit.

D. Fill pipe with chlorine solution of sufficient strength to provide 10 parts per million chlorine residual at end of 24 hours.

E. Flush pipes with potable water until chlorine residual is less than 0.6 parts per million before pipes are put into service.

1.07 CLOSEOUT DOCUMENTS

A. Submit the following before Substantial Completion:
   1. Punch list of items to be completed or corrected with the request for issuance of Substantial Completion.
   2. Evidence of Compliance with Requirements of Governing Authorities.
   3. Project Record Documents.
   4. Approved Operation and Maintenance Manuals.
   5. Approved Warranties and Bonds.
   6. Keys and Keying Schedule.
   7. Completed Contract requirements for Commissioning and process Start-Up.

B. Submit the following before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Punch list items have been completed and the Engineer and Owner are satisfied that all deficiencies are corrected.
   2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
   3. Release of claims as outlined in Conditions of the Contract.
   4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
   5. Final statement of accounting.
   6. Submit Final (As-Built) Schedule as specified in Section 01321 - Schedules and Reports.

1.08 PROJECT RECORD DOCUMENTS

A. Maintain at the Project Site, available to the Owner and Engineer, 1 copy of the Contract Documents, Shop Drawings, and other Submittals in good order:
   1. Mark and record field changes and detailed information contained in Submittals and Change Orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
   4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
   5. Provide schedules, lists, layout drawings, and wiring diagrams.
   6. Make annotations in electronic format. in accordance with the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue
Dimensions:	Graphite

B. Maintain documents separate from those used for construction:
   1. Label documents “RECORD DOCUMENTS.”

C. Keep documents current:
   1. Record required information at the time the material and equipment is installed and before permanently concealing.
   2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.

D. Affix civil engineer’s or professional land surveyor’s signature and registration number to Record Drawings to certify accuracy of information shown.

E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor’s name and address, list of documents, and signature of the Contractor.

F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.

G. Updated Record Documents are a condition for the Engineer’s recommendation for progress payment.

H. Final Schedule Submittal as specified in Section 01321 - Schedules and Reports.

1.09 MAINTENANCE SERVICE

A. As specified in Technical Specifications.

1.10 SUBSTANTIAL COMPLETION

A. Obtain Certificate of Substantial Completion.

1.11 FINAL COMPLETION

A. When Contractor considers the Work is complete, submit written certification that:
   1. Work has been completed in accordance with the Contract Documents.
   2. Punch list items have been completed or corrected.
   3. Work is ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness.

C. Should the Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective Work.
   2. Contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to the Engineer that the Work is complete.
   3. Engineer shall re-inspect the Work.

1.12 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer at least 7 days prior to final Application for Payment.

B. Statement shall reflect all adjustments to the Contract amount.
   1. The original Contract amount.
   2. Additions and deductions resulting from:
      a. Change Orders.
      b. Units installed and unit prices.
      c. Set-offs for uncorrected or incomplete Work.
      d. Set-offs for liquidated damages.
      e. Set-offs for reinspection payments.
      f. Extended engineering and/or inspection services and inspection overtime.
      g. Excessive Shop Drawings review cost by the Engineer.
      h. Other adjustments.
   3. Total Contract amount, as adjusted.
   4. Previous payments.
   5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

1.13 FINAL APPLICATION FOR PAYMENT

A. Submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

PART 2 PRODUCTS (NOT USED)

2.01 SPARE PARTS

A. Deliver spare parts as specified in Section 01600 - Product Requirements.

B. Owner may request advanced delivery of spare parts, maintenance products, and special tools.
   1. Deduct the delivered items from the inventory list and provide transmittal documentation.

C. Prior to Substantial Completion, arrange to deliver spare parts, maintenance products, and special tools to Owner at a location on site chosen by the Owner.
   1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
   2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01782

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Preparation and submittal of manual with requirements to operate and maintain the equipment.

1.02 PREPARATION

A. General requirements:
   1. Provide dimensions in English units.
   2. Assemble material, where possible, in the same order within each volume.
   3. Reduce drawings and diagrams to 8 1/2 by 11-inch size, if possible unless otherwise specified.
   4. Complete forms on computer, handwriting not acceptable.
   5. Delete items or options not provided in the supplied equipment or system.
   6. Provide package control system annotated ladder logic for PLC, if applicable.

B. Hard copy requirements:
   1. Binders: 3-ring with rigid covers.
      a. Break into separate binders as needed to accommodate large size.
   2. Utilize numbered tab sheets to organize information.
   3. Provide original and clear text on reproducible non-colored paper, 8 1/2 by 11-inch size, 24 pound paper.
   4. Drawings larger than 8 1/2 by 11 inch:
      a. Fold drawings separately and place in envelope bound into the manual.
      b. Label each drawing envelope on the outside regarding contents.

C. Electronic requirements:
   1. File format:
      a. Entire manual in PDF format.
         1) Include text and drawing information.
         2) Provide a single PDF file even if the hard copy version is broken into separate binders due to being large.
         3) Create PDF from the native format of the document (Microsoft Word, graphics programs, drawing programs, etc.).
            a) If material is not available in native format and only available in paper format, remove smudges, fingerprints, and other extraneous marks before scanning to PDF format.
            b) Hard copy record drawing requirements:
               (1) Provide a single multipage PDF file of each set of the scanned drawings.
               (2) Page 1 shall be the cover of the drawing set.

c) At file opening, display the entire cover.
(1) Scan drawings at 200 to 300 dots per inch (DPI), black and white, Group IV Compression, unless otherwise specified.
(2) Scan drawings with photos in the background at 400 dots per inch (DPI), black and white, Group IV Compression.
4) Pagination and appearance to match hard copy.
5) Searchable.
6) Scanned images are not acceptable.
7) Bookmarks:
a) Bookmarks shall match the table of contents.
b) Bookmark each section (tab) and heading.
c) Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
d) At file opening, display all levels of bookmarks as expanded.
8) Thumbnails optimized for fast web viewing.
b. Drawing requirements:
1) Provide additional copy of drawings in most current version of AutoCAD format.
2) Drawings shall have a white background.
3) Drawing shapes shall not degrade when closely zoomed.
4) Screening effects intended to de-emphasize detail in a drawing must be preserved.
5) Delete items or options not provided in the supplied equipment or system.
2. Media:
a. USB flash drive.
b. Secure File Transfer Protocol (SFTP).
3. Label media with the following information:
a. Operation and Maintenance Manual.
b. Equipment name.
c. Specification Section Number.
d. Equipment tag number.
e. Owner's name.
f. Project number and name.
g. Date.
4. If multiple submittals are made together, each submittal must have its own subdirectory that is named and numbered based on the submittal number.

1.03 CONTENTS

A. Table of Contents: General description of information provided within each tab section.

B. Complete Attachment A - Equipment Summary Form.

C. Description of system and components.

D. Description of equipment function, normal operating characteristics, and limiting conditions.

E. On-line resources.

F. Telephone resources.

G. Approved submittals.
   1. Markup with any field changes.
   2. Final programming.

H. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

I. Operating procedures:
   1. Step-by-step instructions including but not limited to the following:
      a. Safety precautions and applicable Safety Data Sheets.
      b. Guidelines.
      c. Other information as needed for safe system operation and maintenance.

J. Preventative maintenance procedures:
   1. Recommended steps and schedules for maintaining equipment.
   2. Troubleshooting.

K. Lubrication information: Required lubricants and lubrication schedules.

L. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

M. Manufacturer's technical reference manuals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - EQUIPMENT SUMMARY FORM

EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT TAG NUMBER(S) _____

4. LOCATION OF EQUIPMENT _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

_____

_____

_____

6. NAMEPLATE DATA -
   - Horsepower _____
   - Amperage _____
   - Voltage _____
   - Service Factor (S.F.) _____
   - Speed _____
   - ENC Type _____
   - Capacity _____
   - Other _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

   Name _____

   Address _____

   Telephone Number _____

8. MAINTENANCE REQUIREMENTS:

Maintenance Operation	Frequency	Lubricant (if applicable)	Comments
(List each operation required. Refer to specific information in Manufacturer's Manual, if applicable)	(List required frequency of each maintenance operation)	(Refer by symbol to lubricant list as required)	

9. LUBRICANT LIST:

Reference Symbol	Conoco Phillips	Exxon/Mobil	BP/Amoco	Other (List)
(Symbols used in Item 7 above)	(List equivalent lubricants, as distributed by each manufacturer for the specific use recommended)			

10. SPARE PARTS (recommendations)_____

_____

11. COMMENTS_____

12. GENERAL INFORMATION:

Date Accepted*: _____

Expected Life*: _____

Project Name & Number: _____

Design Engineer: _____

13. WARRANTY:

Start Date: _____

Expiration Date: _____

Prorated: _____

SECTION 01783

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Warranty and bonds requirements.

1.02 SUBMITTALS

A. For each item of material or equipment furnished under the Contract:
   1. Submit manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
   2. Submit manufacturer's special warranty when specified.

B. Provide consolidated warranties and bonds within 15 calendar days of Substantial Completion.
   1. Contents:
      a. Organize warranty and bond documents:
         1) Include Table of Contents organized by Specification Section number and the name of the product or work item.
      b. Include each required warranty and bond in proper form, with full information, certified by manufacturer as required, and properly executed by Contractor, or subcontractor, supplier, or manufacturer.
      c. Provide name, address, phone number, and point of contact of manufacturer, supplier, and installer, as applicable.
   2. Hardcopy format:
      a. Submit 2 copies.
      b. Assemble in 3 D-side ring binders with durable cover.
      c. Identify each binder on the front and spine with typed or printed title "Warranties and Bonds"; Project Name or Title, and the Name Address and Telephone Number of the Contractor.
   3. Electronic copy in PDF format:
      a. Submit 1 copy.

1.03 OWNER'S RIGHTS

A. Owner reserves the right to reject warranties.

B. Owner reserves the right to refuse to accept Work for the project if the required warranties have not been provided.

1.04 RELATIONSHIP TO GENERAL WARRANTY AND CORRECTION PERIOD

A. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both Contractor's general warranty and the correction period requirements.

B. Disclaimers and limitations in specific materials and equipment warranties do not limit Contractor’s general warranty, nor does such affect or limit Contractor’s performance obligations under the correction period.

1.05 MANUFACTURER’S 1 YEAR WARRANTY MINIMUM REQUIREMENTS

A. Written warranty issued by item’s manufacturer.

B. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Contractor.

C. Covers all costs associated with the correction of the defect, including, but not limited to, removal of defective parts, new parts, labor, and shipping.

D. Provides a timely response to correct the defect.
   1. Manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the treatment process, as defined by Owner.

E. Warranty commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.

F. Duration of warranty: 1 year.

1.06 MANUFACTURER’S SPECIAL WARRANTY

A. Manufacturer’s special warranty is a written warranty published by the manufacturer which includes the requirements as specified in the Technical Section.
   1. Project-specific information and requirements.
   2. Properly executed by product manufacturer.
   3. Expressly states that its provisions are for the benefit of the Contractor or Owner.
   4. Manufacturer’s special warranties commence on the date that the associated item is certified by Engineer as substantially complete.

1.07 WARRANTY WORK

A. Contractor’s responsibilities:
   1. Manufacturer’s disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the product, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with Contractor.

B. Replacement cost:
   1. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of the Contract Documents.
      a. Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.

C. Related damages and losses:
   1. When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.

D. Owner's recourse:
   1. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.

E. Reinstatement of warranty:
   1. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
      a. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

1.08 IMPLIED WARRANTIES

A. Warranty of title and intellectual rights:
   1. Except as may be otherwise indicated in the Contract Documents, implied warranty of title required by Laws and Regulations is applicable to the Work and to materials and equipment incorporated therein.
   2. Provisions on intellectual rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.

B. Implied warranties: Duration in accordance with Laws and Regulations.

1.09 BONDS

A. Equipment bond and other bond requirements as specified in the Technical Sections.

B. Bonds commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of bond period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01850

DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design criteria for use in the selection of equipment and appurtenances specified in Technical Sections of these Specifications and indicated on the Drawings.
   2. Criteria for design of systems, components and equipment fabricated off site and shipped to the Work for installation.
   3. Criteria for design of anchors to connect equipment and appurtenances to supports and structures.

B. The criteria in this Section apply throughout the Work, unless additional criteria, or more restrictive criteria, are indicated.
   1. Additional criteria and requirements relevant to specific locations, specific materials, and specific equipment are indicated on the Drawings, and in the Technical Sections.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures. (ASCE 7).

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
   1. ASHRAE Fundamentals Handbook.

C. International Code Council (ICC):
   1. International Energy Conservation Code (IECC).
   2. International Plumbing Code (IPC).

PART 2 PRODUCTS

2.01 DESIGN CRITERIA - SITE INFORMATION

A. Site name: Shell Creek WTP.
   1. Street address: As specified in Section 01110 - Summary of Work.
   2. Site elevation (approximate):
      a. 18 feet above mean sea level.
   3. Groundwater elevation:
      a. For design of buried and partially buried construction:
         1) Assume groundwater level approximately 1 feet below finished grade.

2.02 DESIGN CRITERIA - REGULATORY REQUIREMENTS

A. Requirements of authorities having jurisdiction over the Project are included in Section 01410 - Regulatory Requirements.

2.03 DESIGN CRITERIA - OPERATING ENVIRONMENT

A. Drawings and Technical Sections include additional criteria and requirements relevant to specific locations, materials, and equipment.

B. Outdoor conditions:
   1. IECC: Climate Zone 2A.
   2. ASHRAE site climatic data location: Punta Gorda Airport, WMO 722034.
   3. Temperature criteria: As specified in the following Table: Design Temperatures - Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook.

Table: Design Temperatures - Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook

Condition	Criteria
Hottest Month DB Range:	15.7 degrees Fahrenheit.
Winter:	At or above this temperature 99.6 percent of the time: 38.7 degrees Fahrenheit dry-bulb.
Summer:	At or above this temperature 0.4 percent of the time: 93.4 degrees Fahrenheit dry-bulb.

   1. Rainfall intensity:
      a. Reference: 2023 Florida Plumbing Code:
         1) 4.5 inches per hour (100-year, 1-hour rainfall).

2.04 DESIGN CRITERIA - STRUCTURAL

A. General:
   1. Criteria for structural design of:
      a. Equipment exposed to outdoor environments.
      b. Equipment supports and bracing, and anchorage of such items to building and non-building structures.
      c. Structures provided for the Work through Delegated Design.
      d. Manufactured and prefabricated structures, and anchorage of such structures to foundations or other supporting elements.
   2. Structural design criteria used by the Engineer of record and required by the building code to be indicated on the Drawings are included in “Design Criteria” notes on the Drawings for each structure.

B. Delegated Design:
   1. As specified in Section 01357 - Delegated Design Procedures.

C. Structure risk category:
   1. Develop design loads and provide detailing in accordance with the provisions of ASCE 7 and the building code specified in Section 01410 - Regulatory Requirements, based on the Structure Risk Category indicated in Table: Project Structures - Risk Category and Seismic Design Information.

D. Wind loads:
   1. Design structures and non-structural components that are exposed to wind to withstand design wind loads.
      a. Reduction of wind loads based on shielding effects of surrounding structures or components is not allowed.
      b. Design for wind loading is not required for non-structural components and for non-building structures located inside enclosed buildings.
   2. Design parameters:
      a. Basic wind speed:
         1) 159 miles per hour (33 feet, 3 second gust).
      b. Exposure category: C.
      c. Topographic factor, Kzt: 1.0.

E. Rainfall loads:
   1. Determine rainfall loads using rainfall intensity specified in this Section, and including effects of exposed surface slope, height above surface to discharge elevation, and deflection of ponded surfaces.

F. Operational loads:
   1. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), surge or “water hammer,” and other load conditions.
   2. Design for loads indicated by the equipment manufacturer.
   3. Design for loads indicated in the Technical Sections for equipment and appurtenances.

G. Serviceability considerations: ASCE 7-16.
   1. Deflection, unless otherwise indicated on the Drawings, or specified:
      a. Beam deflection as fraction of span:
         1) Walkways and platforms: Total load = L/240; live load = L/360.
         2) Equipment supports: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Design approach and criteria in accordance with:
   1. Regulatory requirements, including but not limited to the building code specified in Section 01410 - Regulatory Requirements.
   2. Reference standards and project-specific design criteria listed in this Section.
   3. Specific requirements for individual elements and components of the Work as specified in subsequent Technical Sections.

B. In the event of conflicts between design criteria, contact Engineer for interpretation.

C. Where Owner-Delegated Design is required by the Specifications, prepare and submit designs as specified in Section 01357 - Delegated Design Procedures.

3.02 DELEGATED DESIGN

A. Where Delegated Design is required by the Technical Sections, prepare and submit designs as specified in Section 01357 - Delegated Design Procedures.

B. Calculations:
   1. Where submittal of calculations is required:
      a. Provide complete calculations, including sketches to illustrate the design concepts being evaluated, and details to fully describe proposed construction.
   2. Requirements for wind design calculations will be waived for the following:
      a. Equipment and components located inside structures, and away from the effects of wind loads.

C. Shop Drawings:
   1. Describing components and manufacturer's requirements for connections.
      a. Include details for connections of components to structures and supports.
      b. Include details for anchoring bracing to structures where required.

3.03 DESIGN - ANCHORS FOR EQUIPMENT, COMPONENTS, AND BRACING

A. General:
   1. Engineer's approval of anchor designs is required before placement of construction that supports or provides bracing for anchored equipment and components.
      a. Prepare anchor designs after Engineer's approval of the products and layout, and before placement of concrete or masonry that supports them.
   2. Adjust equipment pad sizes and add additional anchor confinement reinforcing to provide required strength at anchorage points between equipment and pad, and between pad and structure.
   3. Supports and bracing:
      a. Design and install braces and anchors to transfer forces from equipment and components to the lateral force resisting system of the surrounding structure.
      b. Anchor and brace piping, ductwork, and electrical distribution components so that lateral or vertical displacement does not result in damage to or failure of essential architectural, mechanical, or electrical equipment.
         1) Provide supplementary framing where required to transfer forces.
         2) Detail and locate braces and anchors to minimize differential movements between components and structure.

B. Preparation:
   1. Obtain manufacturer's information:
      a. Weight and dimensions of components.
      b. Layout and location of anchors that connect to equipment base plates, sole plates, skids, or pads.
      c. Sizes of holes for anchors that will be provided in equipment bases or support frames.

C. Analysis and design:
   1. Perform and submit calculations to determine anchor designs at locations where equipment and equipment supports are connected to the supporting structure.
      a. Indicate number, size, type, and material for anchors.
   2. In determining forces at locations where equipment is anchored to structures, include effects of:
      a. Equipment self-weight and operating weight.
      b. Location of equipment center of mass.
      c. Forces from equipment operation including, but not limited to:
         1) Effects of internal contents including weight and sloshing.
         2) Effects of thrust, surge, and water hammer where specified.
         3) Equipment reactions and operating torque.
         4) Equipment vibration.
         5) Thermal effects from equipment and from distribution systems connected to the equipment (piping, ducts, and electrical).
         6) Other load or displacement inducing conditions.
      d. Forces on equipment from loads specified in this Section.
         1) Include effects of wind, snow, and icing loads where applicable.
         2) Design for load combinations indicated in ASCE 7, unless otherwise specified or indicated on the Drawings.
         3) Wind loads: For equipment and tanks with weight that varies based on the volume of contained material, determine anchor forces to accommodate the full range of filled, partially filled, and empty conditions.
   3. Determine forces and overturning moments at equipment supports and at locations where supports are anchored to structures.
      a. Indicate shear force and associated axial force at each anchor.
   4. Do not use friction to resist sliding resulting from or wind forces.
      a. Resist sliding only by direct application of sliding loads to fasteners as bearing, shear, tension, or compression forces.
   5. Using combined shears and axial forces at each anchor, design anchors and anchor groups for ductile failure.
      a. Ductile failure: Anchor yield before failure of base material, typically concrete or masonry, at the anchor.
   6. Anchor selection:
      a. Provide anchors type indicated on the Drawings.
      b. Where anchors are not specifically indicated on the Drawings, select in accordance with the following:
         1) Anchors that resist wind forces:
            a) Cast-in-place forged hex-head anchor bolt.
         2) Anchors loaded in sustained tension:
            a) Cast-in-place forged hex-head anchor bolt.
         3) Anchors for reciprocating, vibrating, and rotating equipment:
            a) Cast-in-place forged hex-head anchor bolt.
      c. Do not use post-installed anchors, mechanical or adhesive, unless:
         1) Post-installed anchors are indicated on the Drawings, or
         2) Post-installed are approved by the Engineer prior to placement of the surrounding concrete or masonry.

d. Anchor diameter:
    1) Select diameter so that hole in base plate is not greater than 125 percent of the nominal diameter of the anchor, nor greater than the diameter of the anchor plus 1/4 inch.

7. Determine number, size, layout, and minimum effective embedment for anchors.
    a. Layout includes anchor spacing and required distance(s) from anchor to edge(s) of supporting concrete or masonry.
    b. Anchors in concrete: Design based on minimum specified 28-day compressive strength, f'c, as follows, unless otherwise indicated on the Drawings for the Work area:
        1) Concrete placed for this Work: f'c = 4500 pounds per square inch.
        2) Existing concrete in place prior to this Work: f'c = 4000 pounds per square inch.
    c. Anchors in masonry: Design based on minimum specified compressive strength, f'm, as follows, unless otherwise indicated on the Drawings for the Work area:
        1) Existing concrete masonry in place prior to this Work: f'm = 1500 pounds per square inch.
8. Prepare Drawings showing construction details of anchor designs.
9. Submit design calculations and Drawings prior to placement of anchors, and of the structural elements to which they will connect.

END OF SECTION

SECTION 05190

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Post-installed steel anchors and fasteners.
   2. Appurtenances for anchoring and fastening.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   7. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   8. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   9. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   10. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
   11. F436 - Standard Specification for Hardened Steel Washers.
   12. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
   13. F594 - Standard Specification for Stainless Steel Nuts.

14. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
15. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
2. AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry.
3. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.
2. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.
3. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 45 degrees above a horizontal line so the fastener resists sustained tension loads.
4. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.
5. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.
6. Terms relating to structures or building environments as used with reference to anchors and fasteners:
    a. Corrosive locations: Describes interior and exterior locations as follows:
        1) Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
    b. Wet and moist locations: Describes locations, other than "corrosive locations," that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
        1) Exterior portions of buildings and structures.
        2) Liquid-containing structures:
            a) Locations at and below the maximum operating liquid surface elevation.
            b) Locations above the maximum operating liquid surface elevation and:
                (1) Below the top of the walls containing the liquid.
                (2) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).

3) Liquid handling equipment:
   a) Bases of pumps and other equipment that handles liquids.
4) Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.
5) Other locations indicated on the Drawings.

c. Other locations:
1) Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Calculations.

1.05 SUBMITTALS

A. General:
1. Submit as specified in Section 01330 - Submittal Procedures and Section 01600 - Product Requirements.

B. Product data:
1. Post-installed anchors:
   a. For each anchor type, manufacturer's data, including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.

C. Delegated Design Submittals:
1. When requesting product substitutions for post installed anchors, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section.

D. Samples:
1. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.

E. Certificates:
1. Cast-in anchors:
   a. Mill certificates for steel anchors that will be supplied to the Site.
2. Post-installed anchors:
   a. Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the Site comply with the materials properties specified.

F. Test reports:
   1. Post-installed anchors: For each anchor type used for the Work:
      a. Current ICC-ES Report (ESR), or equivalent acceptable to the Engineer and the authority having jurisdiction, demonstrating:
         1) Acceptance of that anchor for use under the building code specified in Section 01410 - Regulatory Requirements.

G. Manufacturer's instructions:
   1. Requirements for storage and handling.
   2. Recommended installation procedures, including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
   3. Requirements for inspection or observation during installation.

H. Qualification statements:
   1. Post-installed anchors: Installer qualifications:
      a. Submit list of personnel performing installations. Include letter of training from manufacturer indicating date of manufacturer's training for each installer.

I. Quality Control Submittals:
   1. Test reports.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Post installed anchors shall be in accordance with building code specified in Section 01410 - Regulatory Requirements.
   2. Installers: Post-installed mechanical anchors:
      a. Installations shall be performed by trained installers having at least 3 years of experience performing similar installations with similar types of anchors.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600 - Product Requirements.

B. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.

C. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

D. Protect anchors from weather and moisture until installation.

1.08 PROJECT CONDITIONS

A. As specified in Section 01850 - Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
   1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
      a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
      b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
   2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact the Engineer for clarification.
   3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as specified in this Section.

2.02 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:
   1. Post-installed anchors shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410 - Regulatory Requirements. Reports prepared by other recognized evaluation agencies may be submitted for consideration if acceptable to the Engineer and to the authority having jurisdiction.
      a. Acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.
         2) To resist short-term loads due to wind forces.
         3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.

B. Concrete anchors:
   1. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torquing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. Sometimes referred to as “expansion anchors” or “wedge anchors.”
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
   2. Concrete expansion bolts for anchorage to concrete:
      a. Shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).

b. Performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
c. Manufacturers: One of the following:
1) DEWALT/Powers, PowerStud.
2) Hilti, Kwik Bolt TZ2 Wedge Anchor.
3) Simpson Strong-Tie, Strong-Bolt 2 Wedge Anchor.
d. Materials. Integrally threaded stud, wedge, washer, and nut:
1) Stainless steel: Type 316.
Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

C. Screw anchors:
1. Post-installed concrete anchor that develops tensile strength from mechanical interlock provided by creating a helical “key” that is larger than the diameter of the bolt itself along the length of the anchor shaft.
2. Screw anchors for anchorage to concrete:
a. Shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
b. Performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
c. Manufacturers: One of the following or equal:
1) DEWALT/Powers, Screw-Bolt+ Screw Anchor:
a) With internally threaded head: Vertigo+ Rod Hanging System.
2) Hilti, Hex head, KH-EZ Screw Anchor:
a) With internally threaded head: KH-EZ I Hanger Anchor.
3) Simpson Strong-Tie, Titen® HD Screw Anchor:
a) With internally threaded head: Titen® HD Rod Hanger.
d. Materials:
1) Stainless steel.
2) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5) or equal.

2.03 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
1. Fabricated steel sleeves:
a. Fabricate to the following dimensions unless otherwise indicated on the Drawings:
1) Inside diameter: At least 2 inches greater than bolt diameter.
2) Inside length: Not less than 10-bolt diameters.
3) Bottom plate:
a) Square plate with dimensions equal to the outside diameter of the sleeve plus 1/2 inch each side.
b) Thickness equal to or greater than one-half of the anchor bolt diameter.

b. Carbon steel:
1) Fabricated from ASTM A36 plate and ASTM A53, Grade B pipe.
2) Welded connections: Conform to requirements of AWS D1.1.
3) Hot dip galvanized in accordance with ASTM A153.
c. Stainless steel:
1) Fabricated from ASTM A240 plate and pipe. Type 304L or Type 316L to match type of the anchor bolt.
2) Welded connections: In accordance with AWS D1.6.

2. Plastic sleeves:
a. Use of plastic sleeves is conditional on acceptance by the Engineer.
b. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.
c. Manufacturers: The following or equal:
1) Portland Bolt & Manufacturing Co.

B. Coating for repair of galvanized surfaces:
1. Manufacturers: The following or equal:
a. Jelt, Galvinox.

C. Thread coating: For use with threaded stainless steel fasteners:
1. Manufacturers: One of the following or equal:
a. Bostik, Never-Seez.
b. Oil Research, Inc., WLR No. 111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION - GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.

2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
   1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION - POST-INSTALLED MECHANICAL ANCHORS

A. General:
   1. Install anchors in accordance with the manufacturer's instructions, ACI 355.2, the anchor's ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements specified in this Section, the requirements of the ICC-ES Report shall control.
   2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
   3. After anchors have been positioned and inserted into concrete or masonry, do not:
      a. Remove and reuse/reinstall anchors.
      b. Loosen or remove bolts or studs.

B. Holes drilled into concrete and masonry:
   1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
   2. Accurately locate holes:
      a. Before drilling holes, use a reinforcing bar locator to identify the position of reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
      b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
   3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
      a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await the Engineer's instructions before proceeding.
   4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
   5. Drill using anchor manufacturer's recommended equipment and procedures:
      a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
         1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
         2) Drill bits: Carbide-tipped in accordance with ANSI B212.15. Hollow drills with flushing air systems are preferred.
   6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.

7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
    a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
    b. Repeat cleaning process as required by the manufacturer's installation instructions.
    c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in compliance with the manufacturer's installation instructions.
    1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
	Minimum Effective Embedment Length		Minimum Member Thickness
Nominal Diameter	In Concrete	In Grouted Masonry	
3/8 inch	2-1/2 inch	2-5/8 inch	8 inch
1/2 inch	3-1/2 inch	3-1/2 inch	8 inch
5/8 inch	4-1/2 inch	4-1/2 inch	10 inch
3/4 inch	5 inch	5-1/4 inch	12 inch

E. Screw anchors:
    1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Screw Anchors			
	Minimum Effective Embedment Length		Minimum Member Thickness
Nominal Diameter	In Concrete	In Grouted Masonry	
3/8 inch	2-1/2 inch	3-1/4 inch	8 inch
1/2 inch	3-1/4 inch	4-1/2 inch	8 inch
5/8 inch	4 inch	5 inch	10 inch
3/4 inch	5-1/2 inch	6-1/4 inch	12 inch

    2. Install using equipment and methods recommended by the manufacturer. Continue driving into hole until the washer head is flush against the item being fastened.

3.04 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01450 - Quality Control.
    1. Expenses associated with Work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
   1. Review anchor manufacturer's installation instructions and requirements of the Evaluation Service Report (hereafter referred to as "installation documents") for each anchor type and material.
   2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
   3. Certify in writing that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.05 FIELD QUALITY ASSURANCE

A. Owner's representative will provide on-site observation and field quality assurance for the Work of this Section.
   1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted Submittals, and the manufacturer's installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to the Engineer upon request.
   3. Statement of special inspections: At the end of the Project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete and built into masonry.
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
      b. Anchor rods.
      c. Concrete inserts (all types).
   2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
      a. Anchor:
         1) Type and dimensions.
         2) Material: Galvanized steel, Type 304 stainless steel or Type 316 stainless steel, as specified in this Section or indicated on the Drawings.
         3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
         4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.

3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
    a. Base material (concrete or grouted masonry):
        1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
        2) Material encapsulating embedment is dense and well-consolidated.

D. Special inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
    1. Provide special inspection during installation of the following anchors:
        a. Concrete anchors.
        b. Screw anchors.
    2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors.
        a. Provide continuous special inspection for post-installed anchors in “overhead installations” as defined in this Section.
    3. Requirements for periodic special inspection:
        a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.
            1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new “initial inspection.”
        b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor’s rated strength.
        c. Anchor:
            1) Manufacturer, type, and dimensions (diameter and length).
            2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).
        d. Hole:
            1) Positioning: Spacing and edge distances.
            2) Drill bit type and diameter.
            3) Diameter, and depth.
            4) Hole cleaned in accordance with the manufacturer’s required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
            5) Anchor’s minimum effective embedment.
            6) Anchor tightening/installation torque.
    4. Requirements for continuous special inspection:
        a. Special inspector shall observe all aspects of anchor installation, except that holes may be drilled in their absence provided that they confirm the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
    1. Owner may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.

a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.06 NON-CONFORMING WORK

A. Remove misaligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations using high-strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

3.07 SCHEDULES

A. Provide and install anchor materials as scheduled in the following table.

Required Anchoring Materials by Location				
Location/Exposure			**Materials**	**Notes**
1.	**Anchors into concrete and grouted masonry for attachment of carbon steel, including structural steel and other steel fabrications:**			
	a.	Interior dry areas	Carbon steel - galvanized	
	b.	Locations with galvanized steel structures or fabrications	Stainless steel - Type 304 or 316	1
	c.	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
	d.	Corrosive locations	Stainless steel - Type 316	1
2.	**Anchors into concrete and grouted masonry for attachment of aluminum, stainless steel, or fiber-reinforced plastic (FRP) shapes and fabrications:**			
	a.	Interior dry areas	Stainless steel - Type 304 or 316	1
	b.	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
	c.	Corrosive locations	Stainless steel - Type 316	1
3.	**Anchors for attaching equipment and its appurtenances:**			
	a.	All locations	Stainless steel - Type 316 (unless Type 304 is specifically indicated in the specifications for the equipment.)	1

Notes:

(1) Where anchors are in contact with a metal that differs from that of the anchor, provide isolation sleeves and washers.

END OF SECTION

SECTION 07840

FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: The requirements for providing firestopping.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E814 - Standard Test Methods for Fire Tests of Penetration Firestops Systems.

B. International Conference of Building Officials (ICBO).

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Product data: Submit manufacturer's data and installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Firestopping:
   1. Intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures over 250 degrees Fahrenheit.
   2. Product shall be UL classified and have ICBO approved fire resistance rating up to 3 hours in accordance with ASTM E814.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fill and seal holes or voids in fire rated floors and walls including pipes penetrating between buildings with acceptable firestopping material in accordance with manufacturer's instructions:
   1. Penetrations shall be free of dirt and debris.
   2. Dam penetrations, if required, with an acceptable material.

B. Apply firestopping material to the penetration using a caulking gun, putty knife, or other normal trade tools:
   1. Provide minimum 1/2-inch caulk or putty for 2-hour fire rating with metal pipe.
   2. Provide minimum 1-inch caulk or putty for 3-hour rating with metal or insulated metal pipe.

C. Normal curing time is 7 days; however, seal shall be immediately functional, providing cold smoke, water, and fire seal.

D. Remove damming materials if necessary after cure.

3.02 CLEANING

A. Clean surrounding areas after installation in compliance with manufacturer's instructions.

END OF SECTION

SECTION 11258

CHEMICAL FEEDING EQUIPMENT, GENERAL

PART 1 – GENERAL

1.01 REQUIREMENTS

A. The CONTRACTOR shall furnish and install chemical feeding equipment, complete and operable, in accordance with the Contract Documents.

B. Equipment shall be from manufacturers with a minimum of 10 years of experience in the manufacture and assembly of similar products, with a record of successful installations. Such manufacturers shall maintain a well-established, authorized, local service agency with sufficient spare parts and personnel to respond within 48 hours to any service calls.

C. Unless indicated otherwise, the requirements of this Section apply to all chemical feeding equipment in the Contract Documents.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01330 – Submittal Procedures.

B. Shop Drawings: Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assemblies, parts, devices, pumps, tanks, mixers, supports, panels, and other accessories forming a part of the equipment, plus schematics, diagrams, and panel layouts.

C. Hydraulics: Static Plate Mixer shall include calculations for pressure drop.

D. Certification: The CONTRACTOR shall obtain written certification from each manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and the Drawings, and that the materials are best suited for the chemicals handled.

E. Technical Manuals: Furnish complete operations and maintenance manuals prior to start-up.

F. Spare Parts List: The CONTRACTOR shall obtain from the manufacturer a list of suggested spare parts for each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, etc.

G. Maintenance: Printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units.

H. Field Procedures: Instructions for field procedures for erection, adjustments, inspection, and testing shall be furnished prior to installation of the equipment.

1.03 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Erection and Startup Assistance: Service and instruction assistance by the manufacturer's engineering representative for each equipment unit shall be furnished by the CONTRACTOR during the following period:
   1. One day during erection, unless indicated otherwise in the feed equipment section.
   2. One day during startup, unless indicated otherwise in the feed equipment section.

B. Instruction of OWNER's Personnel: The CONTRACTOR shall furnish the services of a factory service representative to instruct the OWNER's personnel in the operation and maintenance of the equipment. This service shall consist of a minimum one day's visit to the plant for each type of similar equipment.

1.04 GUARANTEES, WARRANTIES

A. After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees that the equipment will operate with the published efficiencies, heads, criteria, and flow ranges and meet these specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature.

PART 2 – PRODUCTS

2.01 GENERAL

A. Wherever it is required that a single manufacturer shall be responsible for the compatible and successful operation of the various components of any equipment unit, it shall be understood to mean that the CONTRACTOR shall provide only such equipment as the designated manufacturer will certify is suitable for use with its equipment and with the further understanding that this in no way constitutes a waiver of any indicated requirements.

B. Manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

C. Where 2 or more units of the same type or size of equipment are required, such units shall be produced by the same manufacturer.

2.02 MATERIALS

A. General: Materials employed in the equipment shall be suitable for the intended application; materials not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. The following table lists the chemicals used for this project and some of the suitable materials for the construction of chemical feeding equipment. Unless the manufacturer proposes more suitable materials, the table shall be adhered to:

Chemical	Solution Strength (%)	Primary Piping Materials	Ancillary Equipment Materials	Elastomeric Seals
Sulfuric Acid (SA) (H2SO4)	93.5	CPVC (Sch 80) Containment Piping PTFE Tubing PVDF Kynar	Halar Hastelloy C PE PVDF Ryton Teflon Type 316 stainless steel	Viton

2.03 APPURTENANCES

A. **Nameplate:** Each piece of equipment shall be provided with a nameplate (of material compatible with chemical), indicating equipment characteristics, capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, serial number, etc.

B. **Pressure Gauges:** Where indicated on Contract Drawings, chemical transfer and metering pumps and other equipment shall be equipped with pressure gauges with diaphragm seals.

C. Wafer Type Chemical Injection Static Mixers: Where indicated on the Drawings, furnish and install wafer type static mixers as follows:
   1. Manufacturer:
      a. Westfall Manufacturing, or Equal.
   2. Schedule:

Chemical Service	Location	Size (inches)	Materials
Sulfuric Acid	MP	3	Epoxy Vinyl Ester Ring, Alloy 20 Plate

D. **Calibration Columns:** Provide Calibration Columns as indicated on the Contract Drawings. Each Calibration Column shall be an acrylic tube with PVC heads. The columns shall be calibrated for 30-second sampling periods and shall have the capacity as indicated in the table below and shall have a maximum height of 30 inches. Each column shall be securely supported at both top and bottom.

Calibration Column Chemical Service	Capacity (Liters)
Sulfuric Acid	0.25

E. **Flow Sight Glass:** Provide sight flow sight glass as indicated on the Contract Drawings. Each sight flow indicator shall be constructed of the material specified below with 150 # rated flanges. The indicator shall be a flutter type. The flow sight glass shall be manufactured by Jacoby Tarbox style 910-FA-FLTR or equal.

Flow Sight Chemical Service	Body Material	Window Material
Sulfuric Acid	CPVC	Borosilicate

F. Pulsation Dampeners:
   1. Manufacturers: One of the following or equal.
      a. Prominent.
      b. PULSAfeeder.
      c. Wallace and Tiernan.
   2. Pulsation dampeners shall be furnished by the chemical feed system manufacturer and installed on the chemical metering pump discharge lines by the CONTRACTOR as indicated on the Drawings.
   3. The dampeners shall be gas or air charged, double diaphragm type complete with gas/air charge valve connection and pressure gauge graduated from 0 to 160 pounds per square inch.
   4. The pulsation dampeners shall have Hypalon diaphragms, ductile iron chamber (exceptions listed in this paragraph), and allow no more than 6 percent discharge pressure fluctuation.
      a. Hydrofluosilicic acid chamber material: CPVC or PVC.
      b. Sodium hypochlorite chamber material: PVC.
      c. Sulfuric acid chamber material: CPVC.
   5. The dampeners shall have intermediate chamber constructed of PVC, located between the two diaphragms, so that no chemicals contact the outer ductile iron chamber sections.

G. Pressure Relief Valves:
   1. Manufacturers: One of the following or equal.
      a. Prominent.
      b. PULSAfeeder.
      c. Wallace and Tiernan.
   2. Relief valves shall be furnished and installed on the chemical metering pump discharge lines by the chemical feeder system manufacturer. As indicated on the drawings.
   3. Valve shall be set at a pressure no greater than 10 pounds per square inch above system pressure when metering pumps are at full capacity, pulsating flow.
   4. Materials, wetted and non-wetted, shall be consistent with the table of compatible materials in paragraph 2.02 of this section.

5. Valve shall be externally adjustable and serviceable without removing from the pump discharge piping.

H. Diaphragm Backpressure Valves:
   1. Manufacturers: One of the following or equal:
      a. Prominent.
      b. PULSAfeeder.
      c. Wallace and Tiernan.
   2. Valves shall be furnished by the chemical metering pump manufacturer and installed by the CONTRACTOR as indicated on the drawings.
   3. The valves shall have a TFE diaphragm, body and seat material to match piping, PVC bonnet, and adjustable spring range of 15-50 pounds per square inch.
   4. Valves shall produce a backpressure no greater than 10 pounds per square inch above valve set pressure when metering pumps operate a full capacity, pulsating flow.

I. Ball Valves Plastic Body: As specified in Section 15111 – Ball Valves.

2.04 TOOLS AND SPARE PARTS

A. Tools: Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for the equipment shall be furnished as a part of the WORK; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts: Furnish spare seals, packing, gaskets, wear rings, and bearings as required by the feed equipment sections.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General: Chemical feeding equipment shall be installed in accordance with governing safety standards, the Shop Drawings, and as indicated.

B. Alignment: Equipment shall be field tested to verify proper alignment, operation as indicated, and freedom from binding, scraping, vibration, shaft runout, leaks, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The WORK shall include furnishing the necessary oil and grease for initial lubrication and testing of all equipment.

END OF SECTION

SECTION 15052

COMMON WORK RESULTS FOR GENERAL PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Basic materials and methods for metallic and plastic piping systems.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B1.1 - Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms).
   2. B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
   3. B18.2.2 - Nuts for General Applications: Machine Screw Nuts; and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
   4. PCC-1 - Pressure Boundary Bolted Flange Joint Assembly.

B. American Water Work Association (AWWA):
   1. C110 - Ductile-Iron and Gray-Iron Fittings.
   2. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   3. C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   4. C151 - Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   2. A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   3. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
   4. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   5. B88 - Standard Specification for Seamless Copper Water Tube.
   6. D395 - Standard Test Methods for Rubber Property—Compression Set.
   7. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
   8. D573 - Standard Test Method for Rubber—Deterioration in an Air Oven.
   9. D1149 - Standard Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment.
   10. D1330 - Standard Specification for Rubber Sheet Gaskets.
   11. D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings.
   12. F37 - Standard Test Methods for Sealability of Gasket Materials.

13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
14. F594 - Standard Specification for Stainless Steel Nuts.
15. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements of Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

D. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Buried pipes: Pipes that are buried in the soil with or without a concrete pipe encasement.
2. Exposed pipe: Pipes that are located above ground, or located inside a structure, supported by a structure, or cast into a concrete structure.
3. Pipes adjacent to a wet wall: Pipe centerline within 10 inches of the wet wall.
4. Underground pipes: Buried pipes - see 1. above.
5. Underwater pipes: Pipes below the top of walls in basins or tanks containing water.
6. Wet wall: A wall with water on at least one side.

PART 2 PRODUCTS

2.01 GENERAL

A. Pipes:
1. Provide new pipe.
2. Piping provided from manufacturers/distributors inventory is subject to the following condition:
a. Provide proof pipe manufactured more than 6 months prior to delivery was stored properly and the material and/or coating was not subjected to ultraviolet (UV) degradation.
3. Mark each piece of pipe in accordance with applicable standards.

B. Materials in contact with drinking water:
1. As specified in Section 01600 - Product Requirements.

C. Coatings and linings requirements shown in the Pipe Schedule, and as modified in the individual pipe Technical Sections.

2.02 LINK TYPE SEALS

A. Characteristics:
1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
2. Links to form a continuous rubber belt around the pipe.

3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.
4. Hardware to be Type 316 stainless steel.
    a. Provide anti-galling lubricant for threads.

B. One of the following or equal:
1. Link-Seal.
2. Pipe Linx.

2.03 FLANGE BOLTS AND NUTS

A. General:
1. Washer: Provide for each nut.
    a. Shall be of the same material as the nut.
2. Nuts: Heavy hex-head.
3. Cut and finish flange bolts to project:
    a. Face of the bolt shall exceed face of nut by 1/16-inch minimum.
    b. A maximum of 1/4 inch beyond outside face of nut after assembly.
4. Tap holes for cap screws or stud bolts when used.
5. Lubricant for stainless steel bolts and nuts:
    a. Chloride-free.
    b. Manufacturers: One of the following or equal:
        1) Huskey, FG-1800 Anti-Seize.
        2) Weicon, Anti-Seize High-Tech.

B. Ductile iron pipe:
1. On exposed pipes with pressures equal to or less than 150 pounds per square inch gauge (psig):
    a. Bolts: In accordance with ASTM A307, Grade B.
    b. Nuts: In accordance with ASTM A563, Grade A.
    c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
2. On exposed pipes with pressures greater than 150 psig:
    a. Bolts: In accordance with ASTM A193, Grade B7.
    b. Nuts: In accordance with ASTM A194, Grade 2H.
    c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
3. On underwater pipes and pipes adjacent to wet walls:
    a. Bolts: In accordance with ASTM A193, Grade B8M.
    b. Nuts: In accordance with ASTM A194, Grade 8M.

C. Plastic pipe:
1. On exposed pipes:
    a. Bolts: In accordance with ASTM A307, Grade B.
    b. Nuts: In accordance with ASTM A563, Grade A.
    c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
2. On underwater pipes and pipes adjacent to wet walls:
    a. Bolts: In accordance with ASTM A193, Grade B8M.
    b. Nuts: In accordance with ASTM A194, Grade 8M.

D. Steel pipe:
   1. Exposed flange bolts, nuts, and washers:
      a. Bolts: ASTM A193, Grade B7 Steel, ASME B1.1 Class 2A Threads, with dimensions in accordance with ASME B18.2.1.
      b. Nuts: ASTM A194, Grade 2H Steel, ASME B1.1 Class 2A Fit, with square or heavy hex dimensions in accordance with ASME B18.2.2.
      c. Washers: In accordance with ASME PCC-1, Appendix M, Type 4.
      d. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
   2. On underwater pipes and pipes adjacent to wet walls:
      a. Bolts: ASTM A193, Grade B8M Stainless Steel, ASME B1.1 Class 2A Threads, with dimensions in accordance with ASME B18.2.1.
      b. Nuts: ASTM A194, Grade 8M Stainless Steel, ASME B1.1 Class 2A Fit, with square or heavy hex dimensions in accordance with ASME B18.2.2.
      c. Washers: In accordance with ASME PCC-1, Appendix M, Type 7.
      d. Bolts: ASTM F593, Alloy Group 7 (630), ASME B1.1 Class 2A Threads, with dimensions in accordance with ASME B18.2.1.
      e. Nuts: ASTM F594, Alloy Group 7, Alloy 630, ASME B1.1 Class 2A Fit, with square or heavy hex dimensions in accordance with ASME B18.2.2.
      f. Washers: In accordance with ASME PCC-1, Appendix M, Type 7.

2.04 MECHANICAL JOINTS BOLTS AND NUTS

A. Bolts, including T-bolts:
   1. Type 316 stainless steel in accordance with ASTM F593.

B. Heavy hex nuts:
   1. Type 316 stainless steel in accordance with ASTM F594.

2.05 GASKETS

A. General:
   1. Suitable for the specific fluids, pressure, and temperature conditions.
   2. Capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure.

B. For flanged joints in polyvinyl chloride and polyethylene piping with NSF 61 requirements:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, with low flange bolt loadings, temperatures equal to and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine, including fluorochemicals and gaseous fluorine.
   2. Material:
      a. Chemical systems: 0.125-inch thick Viton™ rubber.
      b. Sewer and water: 0.125-inch thick SBR.
   3. Manufacturers: One of the following or equal:
      a. Garlock.
      b. John Crane, similar product.

C. For flanged joints in ductile iron or steel water piping with NSF 61 requirements:
   1. Suitable for hot or cold water, pressures equal to and less than 150 pounds per square inch gauge, and temperatures equal to and less than 160 degrees Fahrenheit.
   2. Material:
      a. SBR or neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
      b. Teflon™ ring; or Teflon™ envelope with non-asbestos filler.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

D. For flanged joints in steel drinking water piping in accordance with NSF 61 requirements:
   1. Material: EPDM elastomer, Sulphur cure.
      a. Temperature range: -40 to 275 degrees Fahrenheit.
      b. Operating pressure: 150 psig.
      c. Durometer, Shore A (within 5): 80.
      d. ASTM D412 tensile strength: 1,500 psi.
      e. ASTM D412 elongation: 185 percent.
      f. ASTM D395 B, compression set, 25 percent deflection, maximum percentage 22 hours at 158 degrees Fahrenheit: 25.
   2. Thickness, minimum:
      a. 3/32-inch for less than 10-inch pipe.
      b. 1/8 inch for 10 inch and larger pipe.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Style 98206.
      b. John Crane.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Piping drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
   2. Piping alternatives:
      a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
      b. Alternative pipe ratings:
         1) Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price.

2) Piping of different material may not be substituted in lieu of specified piping.

c. Valves in piping sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.

d. Grooved joints: Use couplings, flange adapters, and fittings of the same manufacturer.

1) Manufacturer's factory trained representative:

a) Provide on-site training for the Contractor's field personnel.

b) Periodically visit the jobsite to verify the Contractor is following best recommended practices.

2) Distributor's representative is not considered qualified to conduct the training or jobsite visits.

e. Flanged joints: Where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

3. Unless otherwise indicated on the Drawings, piping at pipe joints, fittings, couplings, and equipment shall be installed without rotation, angular deflection, vertical offset, or horizontal offset.

B. Wall and slab penetrations:

1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.

2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.

a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.

b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.

c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.

d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.

3. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.

4. Core drilled openings:

a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by the Engineer.

b. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device.

c. Remove dust and debris from hole using compressed air.

C. Exposed piping:

1. Install in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings.

a. Install piping runs plumb and level, unless otherwise indicated on the Drawings.

1) Slope plumbing drain piping with a minimum of 1/4 inch per foot downward in the direction of flow.

2. Install after installing equipment and after piping and fitting locations have been determined.
3. Route piping to preserve headroom, access space and workspace, and to prevent tripping hazards and clearance problems:
    a. Install piping so it does not interfere with the proper and safe operation of equipment and does not block or interfere with ingress or egress, including hatches.
4. Support piping: As specified in Section 15063 - Non-Metallic Pipe Support System:
    a. Do not transfer pipe loads and strain to equipment.
5. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
6. Assemble piping without distortion or stresses caused by misalignment:
    a. Match and properly orient flanges, unions, flexible couplings, and other connections.
    b. Do not subject piping to bending or other undue stresses when fitting piping.
    c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
    d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
    e. Alter piping assembly to fit when proper fit is not obtained.
    f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Venting piping under pressure:
1. Lay piping under pressure flat or at a continuous slope without air traps, unless otherwise indicated on the Drawings.
2. Install plug valves as air bleeder cocks at high points in piping.
    a. Provide 1-inch plug valves for water lines and 2-inch plug valves for sewage and sludge lines, unless otherwise indicated on the Drawings.
3. Provide additional pipe taps with plug cocks and riser pipes along piping as required for venting during initial filling, disinfecting, and sampling.
   Before piping is placed into service, close plug valves and install plugs. Protect plugs and plug valves from corrosion.

E. Restraining above ground piping:
1. At valves and fittings where piping changes direction, changes size, and at ends:
    a. When piping is aboveground or underwater, use mechanical or structural restraints.
    b. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping.
2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
    c. During testing, provide suitable temporary restraints where piping does not require permanent restraints.

F. Connections to existing piping:
   1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
      a. Protect domestic water/potable water supplies from contamination:
         1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         2) Provide devices approved by the owner of the domestic water supply system to prevent flow from other sources into the domestic supply system.
   2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

G. Connections between ferrous and nonferrous metals:
   1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings, especially designed for the prevention of chemical reactions between dissimilar metals.
   2. Nonferrous metals include aluminum, copper, and copper alloys.

H. Flanged connections between dissimilar metals such as ductile iron pipe and steel pipe:
   1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.02 CLEANING

A. Piping cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris.
   2. Perform special cleaning when required by the Contract Documents.

B. Conduct pressure and leak test, as specified in specification Section 15956 – Piping System Testing.

3.03 PIPE SCHEDULE

A. As specified in Attachment A - Pipe Schedule.

END OF SECTION

ATTACHMENT A - PIPE SCHEDULE

PIPE SCHEDULE

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
SA	Sulfuric Acid										
	Aboveground	3	CPVC	150# SCH 80	15230 Plastic Piping and Tubing	SW	125 psig/HH	None	None	Carrier Piping for PTFE Tubing	1” PTFE tubing in 3” carrier pipe
	Aboveground	1-2	PVDF	150# SCH 80	15230 Plastic Piping and Tubing	SW	125 psig/HH	None	None	SA Feed Room Piping	
	Aboveground	3	Alloy 20	150# SCH 10S	15XXX Nickel Alloy Piping and Tubing	FL or WLD	125 psig/HH	None	None	SA Side Stream Piping	
	Aboveground	¼”	CPVC	150# SCH 80	15230 Plastic Piping and Tubing	SW	125 psig/HH	None	None	SA Side Stream Air Bleed	
	Aboveground	24”	316 SST	150# SCH 10S	15286 Stainless Steel Piping and Tubing	FL	125 psig/HH	None	None	RO Permeate/ SA Side Stream	

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments

Abbreviations:

1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 15956 - Piping Systems Testing.
   - AM Air method
   - GR Gravity method
   - HH High head method
   - LH Low head method
   - SC Special case
2. Abbreviations to designate piping include the following:
   - B&SP Bell and spigot
   - BSP Black Steel Pipe
   - CE Ceramic epoxy lining
   - CI Cast iron
   - CISP Cast iron soil pipe
   - CL Class, followed by the designation
   - CM Cement mortar
   - CPVC Chlorinated Polyvinyl Chloride
   - CTP Coal tar pitch
   - DIP Ductile iron piping
   - EPP Epoxy polyurethane coating
   - FL Flange
   - GA Gauge, preceded by the designation
   - GE Grooved end joint
   - GL Glass lined
   - GSP Galvanized steel pipe
   - MJ Mechanical joint
   - MWA Mechanical wedge action
   - NPS Nominal pipe size, followed by the number in inches
   - psi pounds per square inch
   - psig pounds per square inch gauge
   - PE Polyethylene
   - PEE Polyethylene encasement
   - PTW Polyethylene tape wrap
   - PVC Polyvinyl Chloride
   - PVDF Polyvinylidene Fluoride
   - RPO Restrained push-on
   - SCH Schedule, followed by the designation
   - SCRD Screwed-on
   - SST Stainless steel
   - SW Solvent welded
   - VCP Vitrified clay piping
   - WLD Weld

SECTION 15063

NON-METALLIC PIPE SUPPORT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pre-formed non-metallic pipe support systems.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   2. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Anchor: Elements (including hardware) connecting hangers and supports to the structure.
   2. Hardware: Nuts, bolts, straps, clamps, threaded rod, etc.
   3. Supports: Preformed channel or other structural member on which the pipe is mounted.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Supports:
      a. Materials.
      b. Geometry.
      c. Manufacturer.
   2. Hardware:
      a. Materials.
      b. Manufacturer.

C. Shop Drawings.
   1. Dimensioned and scalable Shop Drawings of hangers and supports for piping.

2. Complete details for:
    a. Member sizes and arrangement in hangers and support assemblies.
    b. Connections between members in hangers and support assemblies.
    c. Anchoring hangers and supports to structures.
    d. Bracing for hangers and supports and anchoring of bracing to structures.
3. Include data on connections, attachment hardware and construction to demonstrate that hangers and supports will satisfy the design loading, bracing, and anchoring criteria.

D. Delegated Design Submittals:
1. Hangers and supports - General:
    a. Locations and conditions:
        1) Hangers and supports inside structures.
    b. Required Submittals: Details with supporting calculations for:
        1) Support member arrangement, sizes, and connections.
        2) Connections of hangers, supports, and bracing to the structure.
2. Hangers and supports anchored to concrete and masonry:
    a. Locations and conditions:
        1) Post-installed mechanical anchors in tension.
        2) Post-installed adhesive-bonded all-thread rods in tension.
    b. Required Submittals:
        1) Calculations demonstrating that anchors have a demand/capacity ratio (D/C) not greater than the following when anchor capacity is adjusted for moisture conditions, anchor spacing and edge distances, and sustained loading conditions present at the location of installation.
            a) Post-installed mechanical anchors maximum: 85 percent.
            b) Post-installed adhesive-bonded anchors maximum: 75 percent.

1.06 QUALITY ASSURANCE

A. The supplied system, including pipe clamps, shall be interchangeable with industry standard 1-5/8-inch steel and fiberglass channel framing systems.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600 - Product Requirements.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

A. Mount pipes on Contractor-fabricated supports unless otherwise indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Hangers and supports individually and as a system shall resist weights and code-required forces without deflections and deformations that would damage the supporting elements, the raceway or equipment supported, or the surrounding construction.
   1. Provide the necessary sway bracing to keep support structures from swaying due to lateral forces.
   2. Include live, and dead loads associated with piping, valves, and appurtenances. Consider the content of the pipes in load calculations.
   3. Allowable column loads: As recommended by the manufacturer in published instruction for the column's unsupported height and "K" value for calculating effective column length of not less than 1.0.
   4. Future loads:
      a. Support systems indicated on the Drawings may include spaces intended to accommodate future pipes.
      b. Assume such spaces are occupied by 6-inch diameter ductile iron pipes. Only the number of pipes that would physically fit into the space need be considered.
      c. Include the weight of the pipe contents in determining future loads. Assume pipe contents are water.
   5. Lateral deflection at top of slab mounted supports shall not exceed support height divided by 240, unless otherwise approved by the Engineer.
   6. Spacing of supports: As required to comply with design requirements but not more than 5 feet.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Aickinstrut.
   2. Eaton B-Line.

2.04 MATERIALS

A. Fiberglass:
   1. Supports:
      a. Vinyl ester.
      b. Nominal dimensions: 1-5/8 inch by 1-5/8 inch.
      c. Flame spread rating of 25 or less in accordance with ASTM E84.
      d. Tested in accordance with ASTM D635.
   2. Hardware:
      a. Polypropylene.
      b. Thermal plastic elastomer.
      c. Fiberglass reinforced plastic.

B. Touch-up resin:
   1. As recommended by the manufacturer.

2.05 COMPONENTS

A. Channel framing:
   1. Supplied with integral notches 1 inch on center.
   2. Locate notches on interior flange to prevent slippage of pipe clamps and fittings after installation.

B. Pipe clamps:
   1. Adjustable type: Non-metallic and non-conductive.
   2. Fixed type:
      a. For pipe less than 6 inches in diameter: Non-metallic and non-conductive.
      b. For pipe equal to and greater than 6 inches in diameter: Fiberglass.

C. Channel fittings:
   1. Make fittings and post bases from glass-filled polyurethane or polyester.

D. Cushion strip:
   1. For solvent welded plastic pipes in elevated temperatures, use a thermoplastic elastomer, cushion wrap designed for use from -50 degrees Fahrenheit to 275 degrees Fahrenheit. Add a cushion strip at each pipe support strap that meets these criteria.
      a. Manufacturers: One of the following or equal:
         1) Anvil, AS3792.
         2) Unistrut, P2600 Unicushion.

2.06 ACCESSORIES

A. Anchors:
   1. As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Anchoring methods:
   1. Solid concrete:
      a. Anchor bolts, anchor rods, or post-installed anchors, as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   2. Metal surfaces: Machine screws or bolts.

3. Hollow masonry units:
    a. Post installed anchors as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
4. Wood and metal studs:
    a. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.

B. Recoat or seal drilled holes, cut or scratched surfaces, with products recommended by the manufacturer.

END OF SECTION

SECTION 15076

PIPE IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pipe identification including the following:
   1. Pipe identification markers, flow direction arrows, tags, and bands.
   2. Underground warning tape.
   3. Tracer wire.
   4. Witness markers.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Submit following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following as specified in Section 01770 - Closeout Procedures:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 EXPOSED AND IN-CHASE PIPE IDENTIFICATION

A. For piping with outer diameter greater than or equal to 3/4-inch, provide lettered pipe markers and flow direction arrows:
   1. General requirements:
      a. Pipe markers shall include the following, minimum:
         1) Printed text identifying the pipe fluid.
            a) The text shall be all capital letters matching the text listed in the "Service" column of the Piping Schedule for the corresponding piping system.

2) An arrow identifying the direction of fluid flow.
   a) The arrow can either be integral to the text marker or provided separately. If provided separately, the arrow must be placed immediately adjacent to each text marker, with the arrow aligned with the text such that the text and arrow are both visible from the same viewpoint.
   b) The arrow color shall match the text color, and the arrow background color shall match the text background color.

b. Suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

c. Lettering:

Outside Pipe Diameter Including Covering	Lettering Height
Less than 0.75 inches	N/A
0.75 to 1.5 inches	1/2-inch
1.5 inches to 2 inches	3/4-inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

d. Marker colors:

Marker Color System ID(1)	Fluid service	Text/arrow color	Background color
1	Flammable and oxidizing fluids	Black	Yellow
2	Potable, cooling, boiler feed, and other waters	White	Green
3	Compressed air	White	Blue
4	Fire quenching fluids	White	Red
5	Toxic and corrosive fluids	Black	Orange
6	Combustible fluids	White	Brown
Notes: (1) See Piping Schedule.			

2. Self-adhesive type markers:
   a. Manufacturers: One of the following or equal:
      1) Seton, (of Brady Corporation), Opti Code Pipe Markers.
      2) Marking Services, Inc.
   b. Materials:
      1) Self-adhesive vinyl.
3. Snap-on markers:
   a. Manufacturers: One of following or equal:
      1) Brady Snap-On.
      2) Seton (of Brady Corporation) Setmark.

B. For piping with outer diameter less than 3/4-inch, provide identification tags and flow direction arrows:
   1. Manufacturer: One of the following or equal:
      a. Seton (of Brady Corporation).
   2. Tag and chain materials:
      a. Copper piping: Brass.
      b. Ferrous piping: Type 316 stainless steel.
      c. Plastic piping: PVC.
   3. Flow direction arrow colors shall adhere to the same requirements as for piping with outer diameter greater than or equal to 3/4 -inch, as specified in this Section.

C. Pipe bands:
   1. When bands are required by the Piping Schedule for a specific piping system, provide solid-colored 4-inch wide bands.
      a. Color as specified in the Piping Schedule.
   2. Self-adhesive type.
   3. Suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit.

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground warning tape:
   1. Manufacturer: One of the following or equal:
      a. Seton (of Brady Corporation).
      b. T. Christy Enterprises, Inc.
   2. Material:
      a. Polyethylene tape for prolonged underground use.
      b. Minimum tape thickness: 4 mils.
      c. Overall tape width: 4 inches.
      d. Message: “CAUTION” with the name of the service followed by “LINE BURIED BELOW.” in black lettering on colored background in accordance with approved APWA colors.

Service	**Color**
Potable water	Blue
Reclaimed water, irrigation, and slurry lines	Purple
Sewers and drain lines	Green
Gas, oil, steam, petroleum, chemicals, or other service	Yellow

B. Tracer wire:
   1. Manufacturers: One of the following or equal:
      a. Kris-Tech Wire.
      b. Aegion Corrpro.
   2. Materials: One of the following or equal:
      a. Solid copper conductor.
      b. Thickness minimum: 10 gauge.

c. Insulation:
1) Match insulation color to the color of the pipe being installed.
2) UF type, direct bury.
3) 30 mil HMWPE.

3. Splicing kit:
a. Manufacturers: One of the following or equal:
1) 3M, Model 82 A1N.

4. Station box:
a. Lid and collar materials: Cast iron.
b. Lid type: Locking.
c. Able to withstand heavy traffic loading.
d. Manufacturers: One of the following or equal:
1) CP Test & Valve Products, Inc., Glenn Test Station.
2) Farwest Corrosion Control.

C. Witness markers:
1. Manufacturers: One of the following or equal:
a. Carsonite Composites, Utility Marker.
2. Materials:
a. Glass fiber and resin reinforced thermosetting composite material.
b. UV resistant.
3. Constructed as a single piece.
4. Pointed at the bottom end.
5. Information to be included on the marker:
a. “Caution” (type of service) “Pipeline”.
b. Phone number for Underground Service Alert.
c. Phone number for Owner in case of emergency.
d. Station number.
e. Offset:
1) Only provide offset if marker is not directly over the pipe.
f. Name of appurtenance or fitting (e.g. 45, BO, ARV, etc.).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600 - Product Requirements.

3.02 PREPARATION

A. Prepare and coat piping with the coating systems defined in the Piping Schedule.

B. Prepare surface in accordance with identification product manufacturer's instructions.

3.03 EXPOSED AND IN-CHASE PIPING IDENTIFICATION

A. Identify exposed and in-chase piping with flow direction arrows and lettering (for piping with outer diameter greater than or equal to 3/4-inch) or tags (for piping with outer diameter less than 3/4-inch).

B. Provide lettering (or tags for pipes with outer diameter less than 3/4-inch) and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.
   1. Label all chemical tank fill pipelines at locations that are visible from chemical fill stations.
   2. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.
   3. Do not apply markers, arrows, or tags to piping that is regularly submerged.

C. Where scheduled in the Piping Schedule, space solid-color bands along piping at 10-foot intervals.
   1. Do not apply bands to piping that is regularly submerged.

3.04 BURIED PIPING IDENTIFICATION

A. Underground warning tape:
   1. Non-detectable warning tape:
      a. Place continuous run of warning tape in pipe trench, 12 inches above the pipe.
   2. Detectable warning tape:
      a. Place continuous run of warning tape in pipe trench, 12 inches above the pipe or a greater height if necessary to limit the tape bury depth to 36 inches. Do not bury detectable warning tape deeper than 36 inches.

B. Tracer wire:
   1. Install on all non-metallic pipe.
   2. Install an electrically continuous run of tracer wire along the entire length of the pipe with wire terminations in valve boxes, vaults, or structures.
   3. Install tracer wire on top of the pipe and secure to pipe with tape a minimum of every 10 feet.
   4. Where approved by the Engineer, splice sections of wire together using approved direct bury wire nuts.
      a. Twisting the wires together is not acceptable.

C. Witness markers:
   1. Install over pipe in unpaved open-space areas at intervals not greater than 200 feet.
   2. Place markers at appurtenances located in unpaved areas.
   3. Embed markers at least 18 inches into the soil.

END OF SECTION

SECTION 15110

COMMON WORK RESULTS FOR VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic requirements for valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C111/A21.11 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe Fittings.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   2. A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   3. A536 - Standard Specification for Ductile Iron Castings.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

D. Society for Protective Coatings (SSPC):
   1. SP7 - Brush-Off Blast Cleaning.
   2. SP10 - Near-White Blast Cleaning.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Submit the following information for each valve:
      a. Valve type, size, pressure rating, Cv factor.
      b. Coatings.
      c. Manual valve actuators:
         1) Information on valve actuator including size, manufacturer, model number.
      d. Certified drawings with description of component parts, dimensions, weights, and materials of construction.
      e. Certifications of reference standard compliance:
         1) Submit certification that the valves and coatings are suitable in potable water applications in accordance with NSF 61.
      f. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

C. Provide vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Manuals.
   1. Furnish bound sets of installation, operation, and maintenance instructions for each type of manual valve 4 inches in nominal size and larger, and all non-manual valves. Include information on valve operators.

D. Provide Manufacturer's Certificate of Source Testing.

E. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications:
   1. Valves manufactured by manufacturers whose valves have had successful operational experience in comparable service.

1.05 DELIVERY STORAGE AND HANDLING

A. Protect valves and protective coatings from damage during handling and installation; repair coating where damaged.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Pressure rating:
   1. Suitable for service under minimum working pressures of 150 pounds per square inch gauge.
   2. When a piping system is specified in the Piping Schedule to be tested at a pressure greater than 150 pounds per square inch gauge, provide valves for that piping system with design working pressure which is sufficient to withstand the test pressure.

B. Valve to piping connections:
   1. Metallic valves:
      a. Valves 3 inches nominal size and larger: Flanged ends.
      b. Valves less than 3 inches nominal size: Screwed ends.
   2. Plastic valves in plastic piping systems:
      a. Up to 4 inches: Provide solvent or heat welded unions.
      b. 6 inches and above: Provide solvent or heat-welded flanges.

2.02 MATERIALS

A. Stainless steel: In accordance with ASTM A480, Type 316, or Type 304, UNS Alloy S31600 or S30400.

B. Valve and operator bolts and nuts (not including flange bolts and nuts, which are specified in Section 15052 - Common Work Results for General Piping):
   1. Fabricated of stainless steel for the following installation conditions:
      a. Submerged in sewage or water.
      b. In an enclosed space above sewage or water.
      c. In structures containing sewage or water, below top of walls.
      d. At openings in concrete or metal decks.
   2. Where dissimilar metals are being bolted, use stainless steel bolts with isolation bushings and washers.
   3. Underground bolts: Low-alloy steel in accordance with AWWA C111/A21.11.

C. Bronze and brass alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacture of valve parts; UNS Alloy C83600 or C92200 unless specified otherwise.

D. Cast iron valve bodies: In accordance with ASTM A126, Class 30 minimum.

E. Ductile iron valve bodies: In accordance with ASTM A536, Grade 65-45-12 minimum unless specified otherwise.

2.03 VALVE OPERATORS

A. Valve operator "Open" direction: Open counterclockwise.

B. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels, as indicated on the Drawings.

C. Provide manually operated valves located not more than 6 feet above the operating level with tee handles, wrenches, or handwheels.
   1. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
   2. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.

D. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels.
   1. Chains: Sufficient length to reach approximately 4 feet above the operating level.
   2. Where chains constitute a nuisance or hazard to operating personnel, provide holdbacks or other means for keeping the chains out of the way.

E. Provide an operator shaft extension from valve or valve operator to finished grade or deck level when buried valves, and other valves located below the operating deck or level, are specified or indicated on the Drawings to be key operated; provide 2 inches square AWWA operating nut, and box and cover as specified, or a cover where a box is not required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Preparation prior to installation:
   1. Install valves after the required submittal on installation has been accepted.
   2. Determine after flanged valves and flanged check valves are selected, the face-to-face dimensions of flanged valves and flanged check valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

B. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by Contractor.
   2. Where such additional valves are required as a result of a substitution or change initiated by Contractor.

C. Valve and actuator orientation:
   1. Contractor shall coordinate with valve supplier final orientation of valve and actuator assembly based on Contractor's selection of equipment manufacturers and the valve and piping arrangement as indicated on the Drawings.
      a. Contractor shall rotate valve and/or actuator mounting orientation as specified in this Section unless otherwise indicated on the Drawings.
   2. Install valves with their stems in vertical position above the pipe, except as follows:
      a. Butterfly valves, gate valves aboveground, globe valves, ball valves, and angle valves may be installed with their stems in the horizontal position.
      b. Install buried plug valves with geared operators with their stems in a horizontal position.
   3. Install valves so that handles clear obstructions when the valves are operated from fully open to fully closed.

D. Place top of valve boxes flush with finished grade or as otherwise indicated on the Drawings.

E. Valves with threaded connections:
   1. Install valves by applying wrench on end of valve nearest the joint to prevent distortion of the valve body.
   2. Apply pipe joint compound or Teflon™ tape on external (male) threads to prevent forcing compound into valve seat area.

F. Valves with flanged connections:
   1. Align flanges and gasket carefully before tightening flange bolts.
   2. When flanges are aligned, install bolts and hand tighten.
   3. Tighten nuts opposite each other with equal tension before moving to next pair of nuts.

G. Valves with soldered connections:
   1. Do not overheat connection to prevent damage to resilient seats and metal seat rings.
   2. Position valves in full open position before starting soldering procedure.
   3. Apply heat to piping rather than to valve body.

3.03 COMMISSIONING

A. As specified in this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

C. As specified elsewhere for specific valve types, sizes or actuators.
   1. Source testing.
   2. Manufacturers on site services for Owner Training, Installation Testing, Functional Testing, and during the Process Operational Period.

END OF SECTION

SECTION 15111

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Ball valves.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA):
   1. C507 - Standard for Ball Valves 6 Inch Through 48 Inch.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   3. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15110 - Common Work Results for Valves:
   1. Metal body ball valves: 6 inches and larger only: Submit affidavit of compliance in accordance with AWWA C507.
   2. Operation and maintenance manual.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General: Unless otherwise indicated on the Drawings use:
   1. Metal body ball valves on metallic pipelines.
   2. Plastic body ball valves on plastic pipelines.

B. Do not use metal body ball valves in sodium hypochlorite or sodium bisulfite systems.

2.02 METAL BODY BALL VALVES – FULL PORT (BAV00)

A. Metal body ball valves, less than 6-inch size.
   1. Manufacturers: One of the following, or equal:
      a. Conbraco Industries, Inc., Apollo Valves.
      b. Flow-Tek, Inc.
      c. Metso Automation/Jamesbury.
      d. NIBCO, Inc.
   2. General:
      a. Type: Non-lubricated, full port and capable of sealing in either direction.
      b. End connections:
         1) Threaded or solder ends for sizes 3-inch and smaller.
         2) Class 150 flanged for sizes larger than 3 inches.
            a) Flanges: In accordance with ASME B16.1 standards.
      c. Stem packing: Manually adjustable while valve is under pressure.
      d. Shafts:
         1) Rigidly connected to the ball by a positive means.
            a) Design connection to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
      e. Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
      f. Temperature limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.
   3. Materials:
      a. Valves in copper lines: Bronze body.
      b. Valves in steel and ductile iron piping: Ductile iron or cast steel body.
      c. Valves in stainless steel piping: Stainless steel body, material type to match piping material as specified in Section 15052 - Common Work Results for General Piping.
      d. Valves in alloy 20 piping: Alloy 20 body, material type to match piping material as specified in Section 15052 - Common Work Results for General Piping.
      e. Ball: Type 304 or 316 stainless steel.
      f. Seats: PTFE.
      g. Stem seals: PTFE or Viton™.
      h. Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.

2.03 PLASTIC BODY BALL VALVES – FULL PORT (BAV40)

A. Manufacturers: One of the following or equal:
   1. Asahi America.
   2. Chemtrol Division, NIBCO, Inc.
   3. Georg Fischer Piping Systems.
   4. Hayward Flow Control.
      a. For sodium hypochlorite service, provide model TB-Z. Model TBH-Z shall not be used.
   5. IPEX USA, LLC.
   6. Plast-O-Matic Valves, Inc.

B. General:
   1. Type: Non-lubricated and capable of sealing in either flow direction.
   2. End connections:
      a. 4 inches and smaller size: Socket end true unions for solvent welded connection to adjacent piping.
      b. 6-inch size: Socket end true unions with attached flanges for flanged connection to adjacent piping.
   3. All valves shall have integral ISO 5211 mounting pad for actuator installation.
   4. All valves shall have integral plate for lock-out/tag-out.
   5. Stem: Double o-ring seal with shear point above seal.
   6. Pressure rating: Suitable for the test pressure and maximum temperature of the corresponding piping system listed in the Piping Schedule.

C. Materials:
   1. Body and ball:
      a. PVC piping systems: PVC.
      b. CPVC piping systems: CPVC.
      c. HDPE and PE piping systems: CPVC.
      d. PVDF piping systems: PVDF.
   2. Seats: PTFE (Teflon™).
   3. O-rings: FKM (Viton™).

D. Limit switches, when indicated on the Drawings:
   1. Mechanical cam type with watertight enclosure and suited for remote indication of valve open-close status.
   2. Mount on valve actuator.
   3. Contacts: 120-volt alternating current, 20 amperes at 75 to 100 percent power factor and 24-volt direct current, 5 amperes minimum.

E. Valve actuator:
   1. Valves shall be quarter turn operated with valve seat adjustability.
   2. Manually operated valves: Lever.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

3.02 COMMISSIONING

A. As specified in this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test, as specified in Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 15118

PRESSURE CONTROL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pressure reducing and pressure relief valves for water, air, sludge and chemical service.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

B. ASTM International (ASTM):
   1. A536 - Standard Specification for Ductile Iron Castings.

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 PLASTIC BODY PRESSURE REDUCING VALVES - CHEMICAL OR WATER SERVICE (PRV40)

A. Manufacturers: One of the following or equal:
   1. Plast-O-Matic: Series PRHM.

B. Materials:
   1. Valve body:
      a. PVC piping systems: PVC.
      b. CPVC piping systems: CPVC.
      c. PVDF piping systems: PVDF.
   2. U-cups:
      a. Match gasket/elastomer material of corresponding piping system, as indicated on the Piping Schedule.
   3. Non-wetted metallic components: Stainless steel.

C. Design:
   1. Diaphragm type.
   2. Pressure rating: Not less than 150 pounds per square inch.
   3. In-line or angle pattern design, size as indicated on the Drawings.
   4. End connections: Threaded.
   5. Downstream pressure set point:
      a. Externally adjustable without removing valve from piping system.
      b. Adjustable from 5 to 125 psig.

2.02 PLASTIC BODY PRESSURE RELIEF VALVES FOR CHEMICAL OR WATER SERVICE (PRV24)

A. Manufacturers: One of the following or equal:
   1. Plast-O-Matic, Series RVT, RVDT or TRVDT.
   2. Asahi/America.
   3. Georg Fischer Piping Systems.

B. Materials:
   1. Valve body:
      a. PVC piping systems: PVC.
      b. CPVC piping systems: CPVC.
      c. PVDF piping systems: PVDF.
   2. U-cup seals:
      a. Match gasket/elastomer material of corresponding piping system, as specified in the Piping Schedule.
   3. Adjusting bolt, locknut, control spring and fasteners: Stainless steel.

C. Design:
   1. Pressure rating: Not less than 150 pounds per square inch.
   2. In-line or angle pattern design, size as indicated on the Drawings.
   3. End connections:
      a. 1 inch and smaller: Threaded.
      b. Larger than 1 inch: Flanged.
   4. Relief set point:
      a. Externally adjustable without removing valve from piping system.
      b. Adjustment range:
         1) Valve sizes 2 inches and smaller: 5 to 125 psig.
         2) Valve sizes 3 inches and larger: 5 to 100 psig.
      c. For chemical pump discharge applications, set valve to open at 10 pounds per square inch more than pump discharge pressure at maximum operating point, or as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 - Common Work Results for Valves.

3.02 COMMISSIONING

A. As specified in this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15230

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plastic pipe, tubing, and fittings for systems that are not plumbing systems.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.12 - Cast Iron Threaded Drainage Fittings.

B. ASTM International (ASTM):
   1. D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
   2. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   3. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   4. D1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
   5. D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   6. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   7. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   8. D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   9. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   10. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   11. D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
   12. D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   13. D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
   14. D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   15. D3350 - Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.
   16. D4101 - Standard Specification for Polypropylene Injection and Extrusion Materials.

17. F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
18. F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
19. F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
20. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
21. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
22. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.
23. F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
24. F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
1. C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches to 12 Inches, for Water Transmission Distribution.

D. NSF International (NSF).

E. Plastics Pipe Institute (PPI):
1. TR 31 - Underground Installation of Polyolefin Piping.

1.03 ABBREVIATIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. CPVC: Chlorinated polyvinyl chloride.

C. DR: Dimension ratio.

D. DWV: Drain, waste, and vent.

E. HDPE: High-density polyethylene.

F. ID: Inside diameter of piping or tubing.

G. NPS: Nominal pipe size followed by the size designation.

H. NS: Nominal size of piping or tubing.

I. PE: Polyethylene.

J. PP: Polypropylene.

K. PTFE: Polytetrafluoro-ethylene.

L. PVC: Polyvinyl chloride.

M. PVDF: Polyvinylidene fluoride.

N. SDR: Standard dimension ratio; the outside diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Shop Drawings:
   1. Describe materials, pipe, fittings, gaskets, and solvent cement.
   2. Installation instructions.

D. Certificates:
   1. Manufacturer's certification of date of manufacture of plastic pipe and tubing for each lot delivered.
   2. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.
   3. Product certificates signed by manufacturer of PVDF piping product stating compliance to stated requirements.
   4. Welder certificates (PVDF), certifying that welders comply with the installation procedures as outlined by ASTM D-2657. All training shall be completed prior to job startup.
   5. Supplier Qualifications: Supplier shall demonstrate a minimum of 5 years' experience in design and installation of plastic piping and tubing systems.

1.05 QUALITY ASSURANCE

A. Plastic pipe in potable water applications: Provide pipe and tubing bearing NSF seal.

B. Fusion machine technician qualifications: 1-year experience in the installation of similar PE piping systems from the same manufacturer.

C. Mark plastic pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required in accordance with ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle PE pipe and fittings as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards. PVDF resin shall meet or exceed the requirements outlined for Type II suspension grade homopolymer resin in ASTM D-3222.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste, and vent piping systems need not be pressure rated.

C. Unions:
   1. Unions 2-1/2 inches and smaller: Socket end screwed unions.
   2. Unions 3 inches and larger: Socket flanges with 1/8-inch full-face soft Viton™ gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC Pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:
      a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454 material in accordance with ASTM D1784.
      b. PVC Pipe: Schedule 80 unless otherwise indicated on the Drawings.
   2. Fittings:
      a. Supplied by pipe manufacturer.
      b. Pressure fittings: In accordance with ASTM D2466 or ASTM D2467.
      c. DWV fittings: In accordance with ASTM D2665.
   3. Solvent cement: In accordance with ASTM D2564:
      a. Chemical service: For CPVC or PVC pipe in chemical service, provide the following primer and cement, or equal:
         1) Primer: IPS Corp., Type P70.
         2) Cement: IPS Corp., Type 724 cement or another cement certified by the manufacturer for chemical service.

2.03 PVC PIPING, CLASS TYPE

A. Fittings: Ductile iron with transition gasket sized to accommodate the outside pipe diameter.

B. PVC pipe, Class Type: In accordance with AWWA C900:
   1. Pressure Class: as scheduled in Section 15052 - Common Work Results for General Piping.
   2. Fittings: One of the following, as scheduled and indicated on the Drawings.
      a. For C900: PVC with overwrap reinforcement. Cast iron pipe sizes.
   3. Joint design: Push-on or mechanical joint type as identified in Piping Schedule.
   4. Gaskets: Viton™ in accordance with ASTM D1869 or ASTM F477.

2.04 CPVC PIPING

A. Materials:
   1. CPVC pipe: Schedule 40 or Schedule 80, as specified, in accordance with ASTM F441 and Appendix, CPVC 4120:
      a. Pipe: Extruded from Type IV, Grade 1, Class 23447 material in accordance with ASTM D1784.
      b. Manufacturers: One of the following or equal:
         1) Charlotte Pipe and Foundry Co.
         2) Eslon Thermoplastics, Inc.
         3) GF Harvel.
   2. Fittings: In accordance with ASTM F438 or ASTM F439 for pressure fittings, as appropriate to the service and pressure requirement:
      a. Fittings: Supplied by the pipe manufacturer.
      b. Manufacturers: One of the following or equal:
         1) Colonial Engineering.
         2) Eslon Thermoplastics, Inc.
         3) Chemtrol.
         4) Spears Manufacturing Co.
   3. Solvent cement: In accordance with ASTM F493:
      a. For CPVC pipe in chemical service, utilize IPS Corp., Type 724 cement or another cement certified by the manufacturer for high strength hypochlorite service.

2.05 PVDF PIPING

A. General:
   1. Type II suspension grade homopolymer resin that meets or exceeds the requirements outlined in ASTM D-3222.
      a. Piping: All piping shall be extruded from ASTM D-3222 conforming resin, Solef 1010/0001 HP resin or equal. Piping shall be produced based on an SDR system and calculated utilizing a Hydrostatic Design Basis according to ASTM D 2837.
      b. Fittings: All fittings shall be injection molded and shall have the same wall thickness and pressure ratings as the pipe.

2.06 PTFE TUBING FOR CHEMICAL SERVICE

A. Materials:
   1. Tubing: Scientific grade PTFE fluoropolymer tubing.
      a. Manufacturers: One of the following:
         1) Saint Gobain Performance Plastics, Chemfluor 367
      b. Tubing size: one-half-inch ID, unless otherwise noted on Drawings.
      c. Tubing fittings: Flared PFA fittings, Fit-Line FlareLINK or equal.
   2. Protective sheath: 3-inch nominal pipe size, schedule 80 CPVC piping based on chemical service. Refer to Section 11258 for materials of use for each chemical service.
      a. 90-degree elbows used for protective sheath containment piping are to be long radius 90-degree elbows.

2.07 SOURCE QUALITY CONTROL

A. PVC piping, Schedule Type:
   1. Mark pipe and fittings in accordance with ASTM D1785.

B. PVC piping, Class Type:
   1. Hydrostatic proof testing in accordance with AWWA C900: Test pipe and integral bell to withstand, without failure, two times the pressure class of the pipe for a minimum of 5 seconds.

C. CPVC piping:
   1. Mark pipe and fittings in accordance with ASTM F441.

D. PVDF Piping:
   1. Manufacturer shall test all lots to ensure the melt flow index is within allowable range. Test reports shall be provided with the piping submittal.
   2. Mark pipe to indicate Type II suspension grade homopolymer resin according to ASTM D-3222.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Where not otherwise specified, install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
   2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
   3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
   4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC piping, Schedule Type:
   1. Solvent weld joints in accordance with ASTM D2855:
      a. For PVC pipe in chemical service use IPS Corp., Type 724 cement in accordance with manufacturer's instructions.
   2. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC piping, Class Type:
   1. Install piping in accordance with the Appendix of AWWA C900 complemented with manufacturer's published instructions.

D. Installation of CPVC piping:
   1. Clean dirt and moisture from pipe and fittings.
   2. Bevel pipe ends in accordance with manufacturer's instructions with chamfering tool or file. Remove burrs.
   3. Use solvent cement and primer formulated for CPVC:
      a. For CPVC pipe in chemical service use IPS Corp., Type 724 cement in accordance with manufacturer's instructions.

4. Use primer on pressure and non-pressure joints.
5. Do not solvent weld joints when ambient temperatures are below 40 degrees Fahrenheit or above 90 degrees Fahrenheit unless solvent cements specially formulated for these conditions are utilized.

E. Installation of PVDF Piping:
   1. Prior to pressure testing, the system shall be examined for the following items:
      a. Pipe shall be completed per drawing layout with all pipe and valve supports in place.
      b. Pipe, valves and equipment shall be supported as specified, without any concentrated loads.
      c. Pipe shall be in good condition, void of any cracks, gouges or deformation on the system.
      d. Pipe flanges shall be properly aligned. All flange bolts should be checked for correct torques.
      e. All joints should be reviewed for appropriate welding technique.
         1) Joining Equipment:
            a) Installers shall be pre-qualified through training on welding technique according to ASTM D-2657.
            b) Manufacturer shall provide on-site training in the assembly and installation of the PVDF piping system.
            c) Joining Equipment shall be either butt-fusion or socket fusion method.
         2) Socket--to have two beads on the end of the fitting and on the outside of the pipe in contact.
         3) Joints should have two bead 360-degrees around the joint.
      f. If any deficiencies appear, the quality control manager shall provide directions for repair.
   2. Hanging:
      a. Pipe shall be hung in accordance with manufacturers recommendations to avoid damage to the pipe.
      b. Proper support spacing is required in order to avoid sagging of the material. Support spacing is temperature dependent and shall be based on manufacturer recommendations.

F. Installation of PTFE Tubing for Chemical Service:
   1. Install tubing in accordance with manufacturer's published instructions.
   2. Tubing shall be installed within a 3-inch, schedule 80 PVC or CPVC (as appropriate for chemical service) protective sheath as one continuous run of tubing. Tubing size shall be 1-inch ID, unless otherwise noted on Drawings. Tubing connections shall be installed at terminations of tubing outside of protective sheath.
   3. Furnish and install a 316 stainless steel pull cable and leave inside carrier piping.
   4. Furnish large handholes in protective sheath for pull boxes and maintenance purposes at intervals selected with Owner.
   5. Install view ports in protective sheath every 20 feet for leak detection.
   6. Protective sheaths containing chemical service tubing shall be color coded according to the specific chemical service.

3.02 FIELD QUALITY CONTROL

A. Leakage Test for PVC and CPVC Piping, Schedule Type:
   1. Test in accordance with Section 15956 Piping Systems Testing.

B. Leakage Test for PVC Piping, Class Type:
   1. Polyvinyl-chloride (PVC) Piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 15956.
   2. Pressure Test with Maximum Leakage Allowance: Perform test after backfilling.
      a. Pressure: As scheduled in Section 15052.
      b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	**1-1/2**	**2**	**2-1/2**	**3**	**4**	**6**	**8**	**10**	**12**
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

C. Leakage Test for PVDF Piping:
   1. Test fluid should be deionized water with quality level set by Quality Control Engineer. In all cases, the test must be done hydrostatically. Air is not acceptable.
   2. Filling the system: Open all valves and vents to purge the system of air. Slowly inject the water into the system, making sure that air does not become trapped in the system.
   3. Begin pressurizing the system in increments of 10 psi. Bring the system up to 125 psi and hold. Allow the system to hold pressure for a minimum of two hours and up to a recommended 12 hours. Check the pressure gauge after one hour. Due to natural creep effects on plastic piping the pressure will have decreased. If pressure drop is less than 10 percent pump the pressure back up. At this time the system may be fully pressurized to desired test pressure.
   4. If after one hour the pressure has decreased more than 10 percent, consider the test a failure. Note the 10% value may need to be greater for larger systems, or systems experiencing significant thermal changes.
   5. Test is to be witnessed by the ENGINEER and certified by the CONTRACTOR.
   6. Hidden leaks can be found by emptying the system and placing a 10 psi charge of clean, dry nitrogen on the system. Each joint should then be individually checked using soapy water solution or an Ultrasonic leak detection gun. Leak detection guns should be available from the pipe manufacturer.

END OF SECTION

SECTION 15282

NICKEL ALLOY PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Nickel alloy piping and tubing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.
   3. B16.11 - Forged Fittings, Socket-Welding and Threaded.
   4. B16.9 - Factory-Made Wrought Buttwelding Fittings.
   5. B31.3 - Process Piping.
   6. B36.19 - Stainless Steel and Nickel Alloy Pipe.
   7. SB366 - Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings.
   8. SB463 - Specification for UNS N08020 Alloy Plate, Sheet, and Strip.
   9. SB464 - Specification for Welded UNS N08020 Alloy Pipe.
   10. SB468 - Specification for Welded UNS N08020 Alloy Tubes.
   11. SB473 - Specification for UNS N08020 Nickel Alloy Bar and Wire.
   12. SB564 - Specification for Nickel Alloy Forgings.
   13. SB574 - Specification for Low-Carbon Nickel-Chromium-Molybdenum Alloy Rod.
   14. SB575 - Specification for Low-Carbon Nickel-Chromium-Molybdenum Alloy Plate, Sheet, and Strip.
   15. SB729 - Specification for Seamless UNS N08020 Nickel-Alloy Pipe and Tube.
   16. SB751 - Specification for General Requirements for Nickel and Nickel Alloy Welded Tube.
   17. SB775 - Specification for General Requirements for Nickel and Nickel Alloy Welded Pipe.
   18. SB829 - Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube.
   19. SB906 - Specification for General Requirements for Flat-Rolled Nickel and Nickel Alloys Plate, Sheet, and Strip.
   20. SF467 - Specification for Nonferrous Nuts for General Use.
   21. SF468 - Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.

B. ASTM International (ASTM):
   1. B366 - Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings.
   2. B462 - Standard Specification for Forged or Rolled UNS N08020, UNS N10276 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
   3. B463 - Standard Specification for UNS N08020 Alloy Plate, Sheet, and Strip.
   4. B464 - Standard Specification for Welded UNS N08020 Alloy Pipe.
   5. B468 - Standard Specification for Welded UNS N08020 Alloy Tubes.
   6. B473 - Standard Specification for UNS N08020 Nickel Alloy Bar and Wire.
   7. B474 - Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
   8. B564 - Standard Specification for Nickel Alloy Forgings.
   9. B574 - Standard Specification for Low-Carbon Nickel-Chromium-Molybdenum Alloy Rod.
   10. B575 - Standard Specification for Low-Carbon Nickel-Chromium-Molybdenum Alloy Plate, Sheet, and Strip.
   11. B619 - Standard Specification for Welded Nickel and Nickel-Cobalt Alloy Pipe.
   12. B622 - Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube.
   13. B729 - Standard Specification for Seamless UNS N08020 Nickel-Alloy Pipe and Tube.
   14. B751 - Standard Specification for General Requirements for Nickel and Nickel Alloy Welded Tube.
   15. B775 - Standard Specification for General Requirements for Nickel and Nickel Alloy Welded Pipe.
   16. B829 - Standard Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube.
   17. B906 - Standard Specification for General Requirements for Flat-Rolled Nickel and Nickel Alloys Plate, Sheet, and Strip.
   18. B983 - Standard Specification for Precipitation Hardened or Cold Worked, Seamless Nickel Alloy Pipe and Tube.
   19. B1007 - Standard Specification for Welded Precipitation Hardenable or Cold Worked, Nickel Alloy Tube.
   20. F467 - Standard Specification for Nonferrous Nuts for General Use.
   21. F468 - Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
   22. F2281 - Standard Specification for Stainless Steel and Nickel Alloy Bolts, Hex Cap Screws, and Studs for Heat Resistance and High Temperature Applications.

C. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code.

1.03 SUBMITTALS

A. Submit as specified in Section 013300 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Shop Drawings:
   1. Detailed layout drawings:
      a. Dimensions and alignment of pipes.
      b. Location of valves, fittings, and appurtenances.
      c. Location of field joints.
      d. Location of pipe hangars and supports.
      e. Connections to equipment and structures.
      f. Location and details of shop welds.
   2. Thickness and dimensions of fittings and gaskets.
   3. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   4. Material specifications for pipe, gaskets, fittings, and couplings.
   5. Data on joint types and components used in the system including stub ends, backing flanges, flanged joints, and threaded joints.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Piping layout: Lay out and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints are minimized.
   1. The piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
   2. Where joints and couplings are specifically indicated on the Drawings, design and shop-fabricate piping sections utilizing the joint or coupling illustrated at the locations shown.
   3. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.

B. Shop fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture before shipping to the installation site.

C. Field assembly:
   1. Field welding is prohibited.

2.02 NICKEL ALLOY PIPE

A. General:
   1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall thickness:
   1. As specified in Section 15052 - Common Work Results for General Piping in the Piping Schedule.
   2. Piping 3 inches in nominal diameter and greater:
      a. For general service applications with pressures less than 250 pounds per square inch gauge, pipe diameter 24-inches or less, minimum wall thickness corresponding to Schedule 10S.

C. Fittings for piping 3 inches in nominal diameter and greater:
   1. Material: In accordance with ASTM B463 or B575, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM B366, ASTM B462.
   3. Wall thickness of fitting: In accordance with ASME B36.19 for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.
   5. Dimensional standards:
      a. Fittings with weld ends: In accordance with ASME B16.11.
      b. Fittings with flanged ends: In accordance with ASME B16.5, Class 150.

D. Fittings for piping less than 3 inches in diameter:
   1. Material: In accordance with ASTM B463 or B575, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM B366, B462.
   3. Wall thickness and dimensions of fitting: In accordance with ASME B16.11 and as required for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.
   5. Forgings in accordance with ASTM B462, or barstock in accordance with ASTM B473 or B574. Match forging or barstock material to the piping materials.

E. Piping joints:
   1. Joint types, piping greater than 2 inches in diameter, general:
      a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.
      b. Where type of joint is not specifically indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping, Piping Schedule, design and fabricate piping sections utilizing any of the following joint types:
         1) Welded joints.
         2) Flanged joints.
      c. Joints at valves and pipe appurtenances:
         1) Provide flanged valves and flanged pipe appurtenances in nickel alloy piping systems with flanged ends.
         2) Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using flanged coupling adapters or flanged joints.
      d. Flexible couplings and flanged coupling adapters: Provide nickel alloy construction with materials matching the piping system.
   2. Welded joints:
      a. Piping less than 4 inches in diameter: Single butt-welded joints.
      b. Mark each weld with a symbol that identifies the welder. Flanged joints: Conforming to the requirements in accordance with ASME B16.5, Class 150.

F. Gaskets:
   1. All other service applications: EPDM, nitrile, or other materials compatible with the process fluid.
      a. Drinking water applications: NSF Standard 61 compliant materials only.

G. Bolts for flanges:
   1. Bolts and nuts: Alloy 20 or C276 to match piping material.
      a. Bolt length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut.
      b. Nuts: In accordance with ASTM F467.
      c. Bolts: In accordance with ASTM F468.

H. Fabrication of pipe sections:
   1. Welding: Weld in accordance with ASME B31.3.
   2. Weld seams:
      a. Full penetration welds, free of oxidation, crevices, pits and cracks, and without undercuts.
      b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
      c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
      d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

2.03 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied is in accordance with ASTM B464, B474, B622 or B729. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied are in accordance with ASTM B366 or B462.
   1. Supplementary testing is not required.

D. Examine 3 percent or up to 20 of the factory welds by radiography. For each weld that fails, inspect 3 additional welds using the same methods:
   1. Radiographic methods: In accordance with AWS Standard D1.6 (Chapter 6).
   2. For each weld found to be defective by radiographic methods, examine 3 additional welds using the same method.
   3. Provide interpretation of radiographic pictures by an independent testing laboratory acceptable to the Engineer and submit written report of the findings issued by the laboratory.
   4. Repair or replace defective joints.

E. Thoroughly clean any equipment before use in cleaning or fabrication of nickel alloys.

F. Storage: Segregate location of nickel alloy piping from fabrication of any other piping materials.

G. Shipment to site:
   1. Protect flanges and pipe ends by encapsulating in dense foam.
   2. Securely strap all elements to pallets with nylon straps. Use of metallic straps is prohibited.

3. Cap ends of tube, piping, pipe spools, fittings, and valves with non-metallic plugs.
4. Load pallets so no tube, piping, pipe spools, fittings, or valves bear the weight of pallets above.
5. Notify Engineer when deliveries arrive so Engineer may inspect the shipping conditions.
6. Engineer may reject material due to improper shipping methods or damage during shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping in such a manner as not to impart strain to connected equipment.

B. Slope horizontal lines so that they can be drained completely.

C. Provide valve drains at low points in piping systems.

D. Install eccentric reducers where necessary to facilitate draining of piping system.

E. Provide access for inspection and flushing of piping systems to remove sediment, deposits, and debris.

3.02 FIELD ASSEMBLY OF SHOP-FABRICATED PIPING SECTIONS

A. Join shop-fabricated piping sections together using backing flanges, flexible couplings, flanged coupling adapters, grooved couplings, or flanges.

3.03 FIELD QUALITY CONTROL

A. Test piping to pressure and by method as specified in Section 15956 - Common Work Results for General Piping.
   1. If pressure testing is accomplished with water:
      a. Use only potable quality water.
      b. Piping: Thoroughly drained and dried or place immediately into service.

B. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

3.04 PROTECTION

A. Preserve appearance and finish of nickel alloy piping by providing suitable protection during handling and installation and until final acceptance of the Work.
   1. Use handling methods and equipment to prevent contamination of the nickel alloy surface damage, include the use of wide canvas slings and wide padded skids.
   2. Do not use bare cables, chains, hooks, metal bars, or narrow skids.

3. Store nickel alloy piping and fittings away from any other piping or metals. Storage in contact with ground or outside without projection from harsh weather is prohibited.
4. Protect nickel alloy piping and fittings from carbon steel projections (when grinding carbon steel assemblies in proximity) and carbon steel contamination (do not contact nickel alloys with carbon steel wire brush or other carbon steel tools).

END OF SECTION

SECTION 15286

STAINLESS STEEL PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Stainless steel piping and tubing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.
   3. B16.11 - Forged Fittings, Socket-Welding and Threaded.
   4. B31.3 - Process Piping.
   5. B36.19 - Stainless Steel Pipe.

B. ASTM International (ASTM):
   1. A182 - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 - Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High Pressure or High Temperature Service, or Both.
   4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   8. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   9. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   10. A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   11. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   12. A744 - Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.

13. A774 - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Services at Low and Moderate Temperatures.
14. A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
15. A790 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe.
16. A928 - Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal.
17. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
18. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

C. NSF International (NSF):
1. Standard 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Shop Drawings:
1. Detailed layout drawings:
   a. Dimensions and alignment of pipes.
   b. Location of valves, fittings, and appurtenances.
   c. Location of field joints.
   d. Location of pipe hangars and supports.
   e. Connections to equipment and structures.
   f. Location and details of shop welds.
2. Thickness and dimensions of fittings and gaskets.
3. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
4. Material specifications for pipe, gaskets, fittings, and couplings.
5. Data on joint types and components used in the system including, flanged joints, grooved joint couplings and screwed joints.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Piping layout: Lay out and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints are minimized.
1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
2. Where joints and couplings are specifically indicated on the Drawings, design and shop-fabricate piping sections utilizing the joint or coupling illustrated at the locations shown.

3. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.

B. Shop fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field assembly:
1. Field welding is prohibited.

2.02 STAINLESS STEEL PIPE

A. General:
1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall thickness:
1. Piping 3 inches in nominal diameter and greater:
a. For general service applications with pressures less than 250 pounds per square inch gauge, pipe diameter 24-inches or less, minimum wall thickness corresponding to Schedule 10S.
b. For pressures exceeding 250 pounds per square gauge, minimum wall thickness corresponding to Schedule 80S.
2. Piping less than 3 inches in nominal diameter:
a. Piping with threaded or grooved joints:
1) Minimum wall thickness corresponding to Schedule 40S.

C. Piping material and manufacturing:
1. Comply with the requirements outlined in the following table:

Service	Stainless Steel Grade	Pipe Manufacturing Process
For low chloride water service with chloride concentrates below 200 parts per million and/or free chlorine less than 2 parts per million at ambient temperatures.		
Piping 3 inches in nominal diameter and larger	Type 304L stainless steel in accordance with ASTM A240	In accordance with ASTM A778
Piping less than 3 inches in nominal diameter	Type 304L stainless steel in accordance with ASTM A240	In accordance with ASTM A312
Digester Gas, Oxygen and Ozone Service, Membrane and Reverse Osmosis Filtration Systems with chloride concentrations less than 1,000 parts per million and/or free chlorine less than 4 parts per million at ambient temperatures.		
Piping 3 inches in nominal diameter and larger	Type 316L or LDX 2101 stainless steel in accordance with ASTM A240	Type 316L in accordance with ASTM A778
		Type LDX 2101 in accordance with ASTM A790
Piping less than 3 inches in nominal diameter	Type 316L or LDX 2101 stainless steel in accordance with ASTM A240	Type 316L in accordance with ASTM A312
		Type LDX 2101 in accordance with ASTM A790

Service	Stainless Steel Grade	Pipe Manufacturing Process
Brackish water Membrane and Reverse Osmosis Membrane Filtration Systems with chloride concentrations between 1,000 and 10,000 parts per million.		
All piping diameters	Austenitic or duplex grades of material with PREN greater than 33	In accordance with ASTM A312, ASTM A778, ASTM A790, or ASTM A928
Brackish and Seawater Membrane and Reverse Osmosis Membrane Filtration Systems with chloride concentrations between 10,000 to 20,000 parts per million		
All piping diameters	Austenitic and duplex grades of material with PREN greater than 40	In accordance with ASTM A312, ASTM A790 or ASTM A928
Brackish and Seawater Reverse Osmosis Concentrate (i.e., Brine) with chloride concentrations greater than 20,000 parts per million		
All piping diameters	Austenitic and duplex grades of material with PREN greater than 45	In accordance with ASTM A312, ASTM A778, ASTM A790, or ASTM A928
PREN: Pitting Resistance Equivalency Number PREN = Cr% + (3.3 x Mo%) + (16 x N%)		

UNS #	Alloy	Cr%	Mo%	N%	Other	PREN
N10276	C-276	14.5-16	15-17	-	W 3-4.5	64
S32750	Alloy 2507	24-26	6-8	0.24-0.32	-	48
S32654	654SMO	24-25	7-8	-	-	47
N06625	Alloy 625	20-23	8-10	-	Cb 3.25-4.15	46
N08366	AL6XN	20-22	6-7	-	-	40
N06985	Alloy G	21-23.5	5.5-7.5	-	-	39
S32760	Zeron 100	24-26	3-4	0.2-0.3	W 0.5-1.0	37
S32205	Alloy 2205	22-23	3-3.5	0.14-0.20	-	34
N08904	904L	19-23	4-5	-	-	32
S31726	317LNM	17-20	4-5	0.1-0.2	-	32
N08825	Alloy 825	19-23.5	2.5-3.5	-	-	27
S32101	LDX-2101	21.5	0.3	0.22	-	26
S31603	316L	16-18	2-3	-	-	23
S30403	304L	18-20	-	-	-	18

D. Fittings for piping 3 inches in nominal diameter and greater:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.

2. Manufacturing standard: In accordance with ASTM A774.
3. Wall thickness of fitting: In accordance with ASME B36.19 for the schedule of pipe specified.
4. End configuration: As needed to comply with specified type of joint.
5. Dimensional standards:
    a. Fittings with weld ends: In accordance with ASME B16.11.
    b. Fittings with flanged ends: In accordance with ASME B16.5, Class 150.

E. Fittings for piping less than 3 inches in diameter:
1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
2. Manufacturing standard: In accordance with ASTM A403, Class WP.
3. Wall thickness and dimensions of fitting: In accordance with ASME B16.11 and as required for the schedule of pipe specified.
4. End configuration: As needed to comply with specified type of joint.
5. Forgings in accordance with ASTM A182, or barstock in accordance with ASTM A276. Match forging or barstock material to the piping materials.

F. Piping joints:
1. Joint types, piping greater than 2 inches in diameter, general:
    a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.
    b. Where type of joint is not specifically indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping, Piping Schedule, design and shop-fabricate piping sections utilizing any of the following joint types:
        1) Piping stub ends with backing flanges.
        2) Welded joints.
        3) Flanged joints.
        4) Grooved joints.
    c. Joints at valves and pipe appurtenances:
        1) Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends.
        2) Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using piping stub ends with backing flanges, flanged coupling adapters or flanged joints.
            a) Flexible couplings and flanged coupling adapters: Provide stainless steel construction with materials matching the piping system and in accordance with requirements.
2. Joints in piping 2 inches in diameter and smaller: Flanged, grooved, or screwed with Teflon™ tape thread lubricant, as specified in Section 15052 - Common Work Results for General Piping.
3. Welded joints:
    a. Piping 12 inches and larger in diameter: Automatically weld joints using gas tungsten-arc procedures.
    b. Piping 4 inches through 12 inches in diameter: Double butt welded joints.
    c. Piping less than 4 inches in diameter: Single butt-welded joints.
    d. Mark each weld with a symbol that identifies the welder.
4. Flanged joints: Conforming to the requirements in accordance with ASME B16.5, Class 150.

5. Piping stub ends and backing flanges for pipe 3 inches and larger:
    a. Piping stub ends: Cast stainless steel to match the pipe material with machined gasket and wetted surfaces of stub ends free of crevices, pits, cracks and protrusions.
        1) Manufacturers: The following or equal:
            a) Alaskan Copper Works, Figure SK-38.
    b. Backing flanges: Forged or plate stainless steel (type to match pipe material) with drilled bolt patterns in accordance with ASME B16.1, Class 125 or ASME B16.5, Class 150.
        1) Manufacturers: The following or equal:
            a) Alaskan Copper Works, Figure SK-39 (tube) or SK-39P (pipe).
    c. Stub ends and backing flanges are not allowed for use with wafer style or lugged style valves.
6. Flanges for Schedule 40S and Schedule 80S pipe:
    a. Provide forged stainless steel (type matching piping system) welding neck flanges or slip-on flanges in accordance with ASME B16.5 Class 150.
    b. Material: In accordance with ASTM A182.

G. Gaskets:
1. Ozone and oxygen service: TFE sheet.
2. Aeration air service: As specified in Section 15052 - Common Work Results for General Piping.
3. All other service applications: EPDM, nitrile, or other materials compatible with the process fluid.
    a. Drinking water applications: NSF Standard 61 compliant materials only.

H. Bolts for flanges and stub end/backing flanges:
1. Bolts and nuts: Type 316 stainless steel in accordance with ASTM A193 heavy hex head.
    a. Bolt length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut.
    b. Nuts: In accordance with ASTM A194 heavy hex pattern.
2. For brackish water membrane and reverse osmosis applications: Bolts and nuts: Type 316 stainless steel in accordance with ASTM A351, ASTM A743 and ASTM A744.
    a. Bolts: Stainless steel in accordance with ASTM F593, Group 2, Condition CW.
    b. Nuts: Stainless steel.

I. Fabrication of pipe sections:
1. Welding: Weld in accordance with ASME B31.3.
2. Weld seams:
    a. Full penetration welds, free of oxidation, crevices, pits and cracks, and without undercuts.
    b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
    c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
    d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

J. Cleaning (pickling) and passivation:
   1. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.
   2. Clean (pickle) and passivate in accordance with ASTM A380 or ASTM A967.
      a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible.
         1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.
      b. Passivation treatments with citric acid are not allowed.

   Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

2.03 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied are in accordance with ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied are in accordance with ASTM A774.
   1. Supplementary testing is not required.

D. Thoroughly clean any equipment before use in cleaning or fabrication of stainless steel.

E. Storage: Segregate location of stainless steel piping from fabrication of any other piping materials.

F. Shipment to site:
   1. Protect flanges and pipe ends by encapsulating in dense foam.
   2. Securely strap all elements to pallets with nylon straps. Use of metallic straps is prohibited.
   3. Cap ends of tube, piping, pipe spools, fittings, and valves with non-metallic plugs.
   4. Load pallets so no tube, piping, pipe spools, fittings, or valves bear the weight of pallets above.
   5. Notify Engineer when deliveries arrive so Engineer may inspect the shipping conditions.
   6. Engineer may reject material due to improper shipping methods or damage during shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping in such a manner as not to impart strain to connected equipment.

B. Slope horizontal lines so that they can be drained completely.

C. Provide valve drains at low points in piping systems.

D. Install eccentric reducers where necessary to facilitate draining of piping system.

E. Provide access for inspection and flushing of piping systems to remove sediment, deposits, and debris.

3.02 FIELD ASSEMBLY OF SHOP-FABRICATED PIPING SECTIONS

A. Join shop-fabricated piping sections together using backing flanges, flexible couplings, flanged coupling adapters, grooved couplings, or flanges.

3.03 FIELD QUALITY CONTROL

A. Test piping to pressure and by method as specified in Section 15052 - Common Work Results for General Piping.
   1. If pressure testing is accomplished with water:
      a. Use only potable quality water.
      b. Piping: Thoroughly drained and dried or place immediately into service.

B. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

3.04 PROTECTION

A. Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work.
   1. Use handling methods and equipment to prevent damage to the coating, include the use of wide canvas slings and wide padded skids.
   2. Do not use bare cables, chains, hooks, metal bars, or narrow skids.
   3. Store stainless steel piping and fittings away from any other piping or metals. Storage in contact with ground or outside without projection from bad weather is prohibited.
   4. Protect stainless steel piping and fittings from carbon steel projections (when grinding carbon steel assemblies in proximity) and carbon steel contamination (do not contact stainless steel with carbon steel wire brush or other carbon steel tool).

END OF SECTION

SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Test requirements for piping systems.

1.02 REFERENCES

A. National Fuel Gas Code (NFGC).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.3 - Process Piping.
   3. B31.8 - Gas Transmission and Distribution Piping Systems.

C. Underwriters Laboratories Inc. (UL).

1.03 TESTING REQUIREMENTS

A. General requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052 - Common Work Results for General Piping; are specified in the specifications covering the various types of piping; and are specified in this Section.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01410 - Regulatory Requirements, and UL requirements.
   4. Test natural gas or digester gas piping:
      a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01410 - Regulatory Requirements, or the National Fuel Gas Code, whichever is more stringent.
      b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
   5. When testing with water, the specified test pressure is considered to be the pressure at the lowest point of the piping section under test.
      a. Lower test pressure as necessary (based on elevation) if testing is performed at higher point of the pipe section.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01500 - Temporary Facilities and Controls.

D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test completion: Drain and leave piping clean after successful testing.

G. Test water disposal: Dispose of testing water in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site. All requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be responsibility of Contractor.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Schedule and notification of tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of readiness to test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping.
   3. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection test:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within 1 percent plus or minus.
   4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.02 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
   1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 15052 - Common Work Results for General Piping:
   1. Provide temporary pressure relief valve for piping under test:
      a. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
   2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASME B31.3, ASME B31.8, or the pipe manufacturer's stated maximum working pressure.
   3. Gradually increase test pressure to an initial test pressure equal to the lesser of 1/2 the test pressure or 25 pounds per square inch gauge.

4. Perform initial check of joints and fittings for leakage.
5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage; at each step increase until test pressure reached.
6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.03 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with "GR" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.
      b. For plastic piping test for deflection.
      c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
   2. Inspect piping for visible leaks before backfilling.
   3. Provide temporary restraints when needed to prevent movement of piping.
   4. Pressure test piping with maximum leakage allowance after backfilling.
   5. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours:
      a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
      b. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
      c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of 4 hours while accurately measuring the volume of water added to maintain the test pressure:
         1) Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
            a) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test:
               (1) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
            b) For vitrified clay piping: 500 gallons per day per inch of diameter per mile of piping under test.
            c) For other piping: 80 gallons per day per inch diameter per mile of piping under test.

3.04 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment, or piping specialty safe test pressure allowed by the item's manufacturer.
   4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
   5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
   6. When test results indicate failure of selected sections, limit tests to piping:
      a. Between valves.
      b. Between a valve and the end of the piping.
      c. Less than 500 feet long.
   7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing procedures:
   1. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
   3. Raise pressure to the specified test pressure and inspect piping visually for leaks:
      a. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
   2. Pressure test piping after completion of visible leaks test.
   3. For piping systems using joint designs other than flanged, threaded, or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
      b. Successful completion of the pressure test with maximum leakage allowance shall be achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

c. When leakage is allowed, calculate the allowable leakage by the following formula:

$L = S \times D \times P^{1/2} \times 148{,}000^{-1}$

wherein the terms shall mean:

L = Allowable leakage in gallons per hour.

S = Length of the test section in feet.

D = Nominal diameter of the piping in inches.

P = Average observed test pressure in pounds per square inches gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

x = The multiplication symbol.

3.05 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. General:
   1. Test pressures shall be as scheduled in Section 15052 - Common Work Results for General Piping.
   2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
   3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
   4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible leaks test:
   1. Subject piping under test to specified pressure measured at the lowest end.
   2. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
   4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Pressure test piping after completion of visible leaks test.
   2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours, and no damage to piping and appurtenances has occurred.
      b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

E. Optional joint test:
   1. When joint testing is allowed by note in the Piping Schedule, the procedure shall be as follows:
      a. Joint testing will be allowed only for low head pressure piping.
      b. Joint testing does not replace and is not in lieu of any testing of the piping system or trust restraints.
   2. Joint testing may be performed with water or air.
   3. Joint test piping after completion of backfill and compaction to the top of the trench.
   4. Joint testing with water:
      a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
      b. Maintain test pressure for 1 minute.
      c. Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
      d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
      e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
   5. Joint testing with air:
      a. Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
      b. Maintain test pressure for 2 minutes.
      c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 ELECTRICAL SUBCONTRACTOR QUALIFICATIONS

A. The electrical subcontractor shall meet or exceed the criteria described below:
   1. The electrical subcontractor shall be licensed in the State of Florida.
   2. The electrical subcontractor shall have successfully completed electrical construction on three water treatment plants related projects within the past six years.
   3. It is preferred that the electrical subcontractor have prior electrical construction experience with the City of Punta Gorda Shell Creek WTP within the previous six years.
   4. The electrical subcontractor shall have, in their employ, the following full time employees that will be assigned to perform the electrical work of this contract:
      a. A minimum of (1) Licensed Master Electrician who is overall responsible for the supervision of personnel performing the construction, installation startup and testing of all electrical related facilities and systems.
      b. A minimum of (1) Licensed Journeyman Electrician responsible for the daily construction activities and guidance of the electrical Contractor's on site employees. The Licensed Journeyman's primary assignment will be the construction of the electrical facilities of this project until project completion. The Licensed Journeyman shall be certified in Broward County or shall meet the reciprocity standards of Florida State Statue 489 Part II.
   5. The electrical subcontractor shall not be involved in any current or pending litigation which may have a material negative impact on the ability to complete the project. The electrical subcontractor shall provide a statement advising all current or pending litigations.

1.03 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall meet the atmospheric conditions of the space the equipment is installed in. All electronic boards which are not installed in a conditioned environment shall be fungus-resistant.

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.04 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:
   1. Local Laws and Ordinances.
   2. State and Federal Laws.
   3. National Electrical Code (NEC).
   4. State Fire Marshal.
   5. Underwriters' Laboratories (UL).
   6. National Electrical Safety Code (NESC).
   7. American National Standards Institute (ANSI).
   8. National Electrical Manufacturer's Association (NEMA).
   9. National Electrical Contractor's Association (NECA) Standard of Installation.
   10. Institute of Electrical and Electronics Engineers (IEEE).
   11. Insulated Cable Engineers Association (ICEA).
   12. Occupational Safety and Health Act (OSHA).
   13. National Electrical Testing Association (NETA).
   14. American Society for Testing and Materials (ASTM).
   15. Florida Building Code, including Broward County amendments.

B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the Engineer.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

1.05 ELECTRICAL COORDINATION

A. Work Provided Under this Contract:
   1. Provide and install the complete electrical power distribution system shown on the drawings including equipment space.
   2. Provide and install all electrical equipment indicated on the drawings and described in the specifications including manual modifications of panel boards, modifications of motor control centers, disconnects, local starters, wire, raceway etc. complete in place.
   3. Provide and install all new underground conduit duct banks and wiring indicated on drawings complete in place.
   4. Provide all miscellaneous electrical including switches, terminations, fittings, wiring, conduit, junction boxes, etc. not specified but obviously necessary for a complete working system in place.

B. Temporary Power:
   1. Provide temporary power for all office trailers and for all construction areas. Coordinate with local power and telephone utility for temporary construction power and telephone service during construction.

1.06 SUBMITTALS

A. Quality Control Submittals:
   1. Voltage Field Test Results.
   2. Voltage Balance Report.
   3. Equipment Line Current Report.
   4. Factory test certification and reports for all major electrical equipment.
   5. Site test certification and reports as specified in other Division 16, Electrical sections.
   6. As part of the electrical submittal, the Contractor shall provide a minimum of 1/2”=1’-0” scaled layout of the electrical equipment in the electrical room or major electrical equipment in a mechanical room showing sizes of all equipment and their spatial relationship. Non-electrical equipment shall be approved before finalizing the electrical layout in mechanical rooms.

B. The following information shall be provided for electrical equipment furnished under specifications 16050 Basic Electrical Materials and Methods;:
   1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.

C. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.

D. Provide complete conduit and equipment layouts: a scaled plan layout of the electrical room(s) showing spatial relationships of all equipment as well as the overall size of the room. Minimum scale shall be 1/2”=1’-0”.

E. Provide a conduit plan for major power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits.

1.07 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be designated as corrosive.

B. All indoor chemical and process equipment areas shall be considered wet locations.

C. Electrical equipment in rooms designated as Classified by NFPA 70 (national electrical code) as Division 1 or Division 2 shall meet all requirements set forth for that classification as described in NEC article 500.

1.08 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the Owner. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the Contractor's failure to fulfill this requirement.

C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the Owner. Do such work when directed by the Engineer.

D. After award of Contract, locate all existing underground utilities at each area of construction activity. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost, should damage to underground utilities occur during construction.

1.09 RESPONSIBILITY

A. The Contractor shall be responsible for:
   1. Complete systems in accordance with the intent of these Contract Documents.
   2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, Electrical.
   3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

1.10 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.

B. All electrical equipment sizes and characteristics have been based on manufacturer Eaton Electrical. If the Contractor chooses to and is allowed to substitute, the Contractor shall be responsible for fitting all the equipment in the available space as shown on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency. If a UL listing is not available, equipment shall have a label and listing from a nationally recognized testing laboratory (NRTL) acceptable to the authority having jurisdiction (AHJ) over the project location.

B. Equipment Finish:
   1. Provide manufacturers' standard finish and color, except where specific color is indicated.
   2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panel boards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 CHECKOUT AND STARTUP

A. Voltage Field Test:
   1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
   2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
   3. Record supply voltage (all three phases simultaneously on the same graph) for 24 hours during normal working day.
      a. Submit Voltage Field Test Report within 5 days of test.

4. Unbalance Corrections:
    a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
    b. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:
    1. Check line current in each phase for each piece of equipment.
    2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
    3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

C. Startup:
    1. Demonstrate satisfactory operation of all 480-volt electrical equipment. Participate with other trades in all startup activities.
    2. Assist the Instrumentation and Control (I&C) Contractor in verifying signal integrity of all control and instrumentation signals.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

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):
      a. C55.1 - Standard for Shunt Power Capacitors.
      b. C62.11 - Standard for Metal-Oxide Surge Arrestors for AC Circuits.
      c. Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.
   2. American Society for Testing and Materials (ASTM):
      a. A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
      c. A570 - Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.
   3. Federal Specifications (FS):
      a. W-C-596 - Connector, Receptacle, Electrical.
      b. W-S-896E - Switches, Toggle, Flush Mounted.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
      c. CP I - Shunt Capacitors.
      d. ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
      e. KS 1 - Enclosed Switches.
      f. LA I - Surge Arrestors.
      g. PB 1 - Panelboards.
      h. ST 20 - Dry-Type Transformers for General Applications.
      i. WD I - General Requirements for Wiring Devices.
   6. National Fire Protection Association (NFPA): 70 - National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 67 - Standard for Panelboards.
      b. 98 - Standard for Enclosed and Dead-Front Switches.
      c. 198C - Standard for Safety High-Interrupting-Capacity Fuses, Current-Limiting Types.
      d. 198E - Standard for Class Q Fuses.
      e. 486E - Standard for Equipment Wiring Terminals.
      f. 489 - Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.
      g. 508 - Standard for Industrial Control Equipment.
      h. 810 - Standard for Capacitors.

i. 943 - Standard for Ground-Fault Circuit Interrupters.
j. 1059 - Standard for Terminal Blocks.
k. 1561 - Standard for Dry-Type General-Purpose and Power Transformers.

1.02 SUBMITTALS

A. Shop Drawings:
1. Device boxes for use in hazardous areas.
2. Junction and pull boxes used at, or below, grade.
3. Hardware.
4. Terminal junction boxes.
5. Panelboards and circuit breaker data.
6. Fuses.
7. Contactors.
8. Transformers.
9. All other miscellaneous material part of this project.
10. Wire pulling compound.

1.03 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

1.04 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following spare parts:
1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:
1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs (Cast Mounting) Manufacturer:
a. Crouse-Hinds; Type FS or FD.
b. Appleton; Type FS or FD.

C. Cast Aluminum:
   1. Material:
      a. Box: Cast, copper-free aluminum.
      b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.
   2. Hubs: Threaded.
   3. Lugs: Cast mounting.
   4. Manufacturers:
      a. Crouse-Hinds; Type FS-SA or FD-SA.
      b. Appleton; Type FS or FD.

D. PVC-Coated Sheet Steel:
   1. Type: One-piece.
   2. Material: Zinc- or cadmium-plated.
   3. Coating: All surfaces; 40-mil PVC.
   4. Manufacturer: Appleton.

E. Nonmetallic:
   1. Box: PVC.
   2. Cover: PVC, weatherproof, with stainless steel screws.
   3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers.

2.02 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Large Sheet Steel Box: NEMA 250, Type 1:
   1. Box: Code-gauge, galvanized steel.
   2. Cover: Full access, screw type.
   3. Machine Screws: Corrosion-resistant.

C. Large Cast Metal Box: NEMA 250, Type 4:
   1. Box: Cast malleable iron, hot-dip galvanize finished, with drilled and tapped conduit entrances.
   2. Cover: Hinged with screws.
   3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
   4. Manufacturers, Surface Mounted Type:
      a. Crouse-Hinds; Series W.
      b. O-Z/Gedney; Series Y.
   5. Manufacturers, Recessed Type:
      a. Crouse-Hinds; Type WJBF.
      b. O-Z/Gedney; Series YR.

D. Large Stainless Steel Box: NEMA 250, Type 4X:
   1. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
   2. Cover: Hinged with screws.
   3. Hardware and Machine Screws: ASTM A167, Type 304 stainless steel.
   4. Manufacturers:
      a. Hoffman Engineering Co.
      b. Robroy Industries.

E. Large Steel Box: NEMA 250, Type 4:
   1. Box: 12-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces, with final ANSI Z55.1, No. 61 gray enamel on exterior surfaces.
   2. Cover: Hinged with screws.
   3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
   4. Manufacturers:
      a. Hoffman Engineering Co.
      b. Robroy Industries.

F. Large Nonmetallic Box:
   1. NEMA 250, Type 4X.
   2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
   3. Cover: Hinged with screws.
   4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
   5. Conduit hubs and mounting lugs.
   6. Manufacturers:
      a. Crouse-Hinds; Type NJB.
      b. Carlon; Series N, C, or H.
      c. Robroy Industries.

G. Concrete Box:
   1. Box: Reinforced, cast concrete.
   2. Cover: Cast iron.
   3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
   4. Manufacturers:
      a. Brooks Products Inc.; No. 36/36T.
      b. Qwikset; W 17.

2.03 WIRING DEVICES

A. Switches:
   1. NEMA WD I and FS W-S-896E.
   2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
   3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
   4. Rating: 20 amps, 120/277 volts.
   5. Color:
      a. Office Areas: Ivory.
      b. Other Areas: Brown.
   6. Switches with Pilot Light: 125-volt, neon light with red jewel, or lighted toggle when switch is ON.
   7. Manufacturers:
      a. Bryant.
      b. Leviton.
      c. Hubbell.
      d. Pass and Seymour.
      e. Arrow Hart.

B. Receptacle, Single and Duplex:
   1. NEMA WD 1 and FS W-C-596.
   2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
   3. High strength, thermoplastic base color.
   4. Color:
      a. Office Areas: Ivory.
      b. Other Areas: Brown.
   5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
   6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
   7. Manufacturers:
      a. Bryant.
      b. Leviton.
      c. Hubbell.
      d. Pass and Seymour.
      e. Sierra.
      f. Arrow Hart.

C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.
   1. Color: Ivory.
   2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.
   3. Size: For 2-inch by 4-inch outlet boxes.
   4. Standard Model: NEMA WD 1 with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
   5. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
   6. Manufacturers:
      a. Pass and Seymour.
      b. Bryant.
      c. Leviton.
      d. Hubbell.
      e. Arrow Hart.

D. Receptacle, Special-Purpose:
   1. Rating and number of poles as indicated or required for anticipated purpose.
   2. Matching plug with cord-grip features for each special-purpose receptacle.

E. Multioutlet Surface Raceway System: Three-wire grounding receptacles, spaced on 6-inch centers with insulated grounding conductor to each receptacle:
   1. Color: Gray with black receptacles.
   2. Manufacturers:
      a. Plugmold; 2000.
      b. Walker; Duct 2GW.

2.04 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:
   1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
   2. Color: To match associated wiring device.
   3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:
   1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
   2. Finish: ASTM A167, Type 302/304, satin.
   3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:
   1. Material: Malleable ferrous metal, with gaskets.
   2. Screw: Oval-head stainless steel.

E. Engraved:
   1. Character Height: 3/16 inch.
   2. Filler: Black.

F. Weatherproof:
   1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
   2. Mounting Screw: Stainless steel:
      a. Cap Spring: Stainless steel.
      b. Manufacturers:
         1) General Electric.
         2) Bryant.
         3) Hubbell.
         4) Sierra.
         5) Pass and Seymour.
         6) Crouse-Hinds; Type WLRD or WLRS.
         7) Bell.
         8) Arrow Hart.
   3. For Switches: Gasketed, cast metal incorporating external operator for internal switch:
      a. Mounting Screw: Stainless steel.
      b. Manufacturers.
      c. Crouse-Hinds; DS-181 or DS-185.
      d. Appleton; FSK-LVTS or FSK-IVS.

G. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for 1-piece drawn type sheet steel boxes.

2.05 LIGHTING AND POWER DISTRIBUTION PANELBOARD (LP, IP, AND PP PANEL)

A. NEMA PB I, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: If not otherwise shown in plans. Applicable to a system with available short-circuit current of 22,000 amperes rms symmetrical at 208Y/120 or 120/240 volts and 65,000 amperes rms symmetrical at 480Y/277 volts.

E. Where ground fault interrupter circuit breakers are indicated or required by code: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

F. Cabinet: As shown on plans.

G. Bus Bar:
   1. Material: Copper, full sized throughout length.
   2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
   3. Neutral: Insulated, rated 150 percent of phase bus bars with at least 1 terminal screw for each branch circuit.
   4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
   5. Lugs and Connection Points:
      a. Suitable for either copper or aluminum conductors.
      b. Solderless main lugs for main, neutral, and ground bus bars.
      c. Subfeed or through-feed lugs as shown.
   6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

H. Circuit Breakers:
   1. NEMA AB 1 and UL 489.
   2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
   3. Noninterchangeable, in accordance with NFPA 70.
   4. Locking: Provisions for handle padlocking, unless otherwise shown.
   5. Type: Bolt-on circuit breakers in all panelboards.
   6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
   7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
   8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
   9. Ground Fault Interrupter:
      a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
      b. Sensor with same rating as circuit breaker and a push-to-test button.

I. Manufacturers:
   1. Eaton Electrical.
   2. Schneider Electric
   3. Or approved equal.

2.06 MINI-POWER CENTER (MPC)

A. General: Transformer, primary and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, Type 4X enclosure. Complete MPC shall be rated for 22,000 amperes RMS symmetrical.

B. Transformer:
   1. Type: Dry, self-cooled, encapsulated.
   2. Insulation: Manufacturer's standard, with UL 1561 temperature rise.
   3. Full capacity, 2-1/2 percent voltage taps, 2 above and 2 below normal voltage.
   4. Primary Voltage: See plans.
   5. Secondary Voltage: See plans.

C. Panelboard: Full, UL 489, short-circuit current rated:
   1. Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case circuit breakers.
   2. Number and Breaker Ampere Ratings: Refer to Panel Schedule.

2.07 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB I, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown or as required.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees Celsius ampacity.

E. Locking: Provisions for padlocking handle.

F. Multipole breakers to automatically open all poles when an overload occurs on 1 pole.

G. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

2.08 FUSED DISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 98 listed for use and location of installation.

B. NEMA KS 1 and UL 98 Listed for application to system with available short circuit current of 22,000 amps rms symmetrical.

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

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees Celsius ampacity.

E. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

F. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

G. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.09 NONFUSEDDISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

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

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees Celsius ampacity.

D. Enclosure: NEMA 250, Type 12, industrial use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.10 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000 ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.
      b. Littlefuse; Type LLS-RK.

D. Motor and Transformer Circuits, 0- to 250-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPN-RK.
      b. Littlefuse; Type LLN-RK.

E. Feeder and Service Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-I, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.
      b. Littlefuse; Type LLS-RK.

F. Feeder and Service Circuits, O- to 250-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-I, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPN-RK.
      b. Littlefuse; Type LLN-RK.

G. Feeder and Service Circuits, 0- to 600-Volt:
   1. Amperage: 601 to 6,000.
   2. UL 198C, Class L, double O-rings and silver links.
   3. Manufacturers:
      a. Bussmann; Type KRP-C.
      b. Littlefuse; Type KLPC.

2.11 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: Push-to-test, LED type. Minimum 22 mm diameter.

D. Pushbutton Color:
   1. ON or START: Black.
   2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:
   1. Material: Aluminum.
   2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of 2 lines, as required, indicating specific function.
   3. Letter Height: 7/64 inch.

G. Manufacturers:
   1. Heavy-Duty, Oiltight Type:
      a. Allen Bradley: 800T.
      b. No approved equal.
   2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
      a. Allen Bradley: 800H.
      b. No approved equal.

2.12 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Terminal Blocks: Provide separate connection point for each conductor entering or leaving box:
   1. Spare Terminal Points: 25 percent.

C. Interior Finish: Paint with white enamel or lacquer.

2.13 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:
   1. Capable of wire connections without special preparation other than stripping.
   2. Capable of jumper installation with no loss of terminal or rail space.
   3. Individual, rail mounted.

I. Marking system allow use of preprinted or field-marked tags.

J. Manufacturers:
   1. Allen Bradley: 1492-J6 series.
   2. No approved equal.

2.14 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:
   1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
   2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:

1. Eaton Electrical; Type M-600.
2. General Electric; Type CR120B.

2.15 RESET TIMER

A. Drive: Synchronous motor, solenoid operated clutch.

B. Mounting: Semiflush, panel.

C. Contacts: 10-amp, 120-volt.

D. Manufacturers:
1. Eagle Signal; Bulletin 125.
2. Automatic Timing and Controls; Bulletin 305.

2.16 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush, panel.

D. Manufacturers:
1. General Electric; Type 240, 2-1/2-inch Big Look.
2. Eagle Signal; Bulletin 705.

2.17 MAGNETIC CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated, electrically held.

C. Main Contacts:
1. Power driven in one direction with gravity dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated 30 amperes, 600-volt.
4. Three-pole.

D. Control: 2-wire.

E. One normally open and one normally closed auxiliary contacts rated 10 amperes at 480-volt.

F. Enclosure: NEMA 250, Type 12, unless otherwise shown.

G. Manufacturers:
1. Eaton Electrical.
2. General Electric; CR 353.
3. Allen-Bradley; Bulletin 500 Line.

2.18 MAGNETIC LIGHTING CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated by dual-acting, single coil mechanism.

C. Inherently interlocked and electrically held in both OPEN and CLOSED position.

D. Main Contacts:
   1. Power driven in both directions.
   2. Double-break, continuous-duty, rated 20 amperes, 600 volts, withstand rating of 22,000 amps rms symmetrical at 250 volts.
   3. Marked for electric discharge lamps, tungsten, and general-purpose loads.
   4. Position not dependent on gravity, hooks, latches, or semi-permanent magnets.
   5. Capable of operating in any position.
   6. Visual indication for each contact.

E. Auxiliary contact relay for three-wire control.

F. One normally open and one normally closed auxiliary contacts rated 10 amperes at 480-volt.

G. Fully rated neutral plate.

H. Provision for remote pilot lamp with use of auxiliary contacts.

I. Clamp type, self-rising terminal plates for solderless connections.

J. Enclosure: NEMA 250, Type 12, Dust-Tight, Drip-Tight, Industrial Use, unless otherwise shown.

K. Manufacturers:
   1. ASCO.
   2. Westinghouse; Class A202.
   3. General Electric; Class 360.
   4. Eaton Electrical.
   5. Square D.

2.19 INDUSTRIAL CAPACITORS

A. UL 810, NEMA CP1, ANSI C55.1, and NFPA 70, Article 460.

B. Enclosed, outdoor, weatherproof, three-phase capacitor units containing internally mounted, indicating type, high interrupting-capacity, current limiting fuses and discharge resistors.

C. Units containing PCB dielectric fluid are unacceptable.

D. Kilovar Ratings:
   1. Kilovar ratings of capacitors connected to individual motor circuits were selected based on expected motor power factor.

2. Check motor nameplate and manufacturer's power factor and no-load current data for actual motor installed.
3. Reduce capacitor kVAR if required, so the size does not exceed the motor manufacturer's recommended maximum size, and so it does not exceed the value required to raise motor no-load power factor to 0.95.
4. Manufacturers:
   a. ABB.
   b. Square D.

2.20 THERMOSTAT

A. Rating: 7.4 amps continuous, 44 amps locked rotor current at 120 volts and 3.7 amps continuous, 22 amps locked rotor current at 240 volts.

B. Line voltage, single-stage, treated to resist corrosion, dust, dirt, and humidity with sealed SPDT contacts.

C. Heating Adjustment Range: 35 to 100 degrees Fahrenheit.

D. Cooling or Ventilating Adjustment Range: 70 to 140 degrees Fahrenheit.

E. Manufacturer: Honeywell; Type T631F1084.

2.21 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Self-cooled, 2-winding, UL K-4 rated for nonlinear loads.

C. Insulation Class and Temperature Rise: Manufacturer's standard.

D. Core and Coil:
   1. Encapsulated for single-phase units 1/2 to 25 kVA and for 3-phase units 3 to 15 kVA.
   2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for 3-phase units 30 kVA and above.

E. Enclosure:
   1. Single-Phase, 3 to 25 kVA: NEMA 250, Type 3R, non-ventilated.
   2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
   3. Three-Phase, 3 to 15 kVA: NEMA 250, Type 3R, nonventilated.
   4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
   5. Outdoor Transformers: NEMA 250, Type 3R.

F. Wall Bracket: For single-phase units, 15 to 37-1/2 kVA, and for 3-phase units, 15 to 30 kVA.

G. Voltage Taps:
   1. Single-Phase, 3 to 10 kVA: Four 2-1/2 percent, full capacity; 2 above and 2 below normal voltage rating.

2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; 2 above and 2 below normal voltage rating.
3. Three-Phase, 3 to 15 kVA: Four 2-1/2 percent, full capacity; 2 above and 2 below normal voltage rating.
4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; 2 above and 2 below normal voltage rating.

H. Impedance: 4.5 percent minimum on units 75 kVA and larger.

I. Maximum Sound Level: NEMA ST 20:
1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.
3. 50 decibels for 51 to 150 kVA.
4. 55 decibels for 151 to 300 kVA.
5. 60 decibels for 301 to 500 kVA.

J. Vibration Isolators:
1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

K. Manufacturers:
1. Square D.
2. General Electric.
3. Eaton (Cutler Hammer).
4. Or approved equal.

2.22 LOW VOLTAGE, SECONDARY SURGE PROTECTIVE EQUIPMENT

A. NEMA LA1, ANSI C62. 11.

B. Surge Capacitor:
1. Impregnated with non-PCB, biodegradable dielectric fluid.
2. Integral discharge resistor which will drain residual voltage to 50 volts crest in less than I minute after disconnection from circuit.

C. Arrestor: High strength metal oxide valve elements enclosed in high strength, corrosion resistant, molded resin housing.

D. Equip capacitor and arrestor with mounting nipple, flat washer, and nut suitable for knockout or bracket mounting.

2.23 SUPPORT AND FRAMING CHANNELS

A. Material:
1. Dry indoors - galvanized.

2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

B. Finish:
   1. Dry indoors - galvanized.
   2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

C. Inserts: Continuous.

D. Beam Clamps: Gray cast iron.

E. Manufacturers:
   1. B-Line.
   2. Unistrut.

2.24 NAMEPLATES

1. Refer to WMWD Electrical ID Standard document to section 3 and section 4 for exact Physical Tag Specification requirements.

2.25 SURGEPROTECTIVE DEVICES

A. This section describes the material and installation requirements for transient voltage surge suppression devices (SPD) in switchboards, panelboards, and motor control centers for the protection of all AC electrical circuits.

B. SPD shall be listed and component recognized in accordance with UL 1449 and UL 1283.

C. SPD shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer’s factory.

D. SPD shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. SPD shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device only.

G. SPD shall meet or exceed the following criteria:
   1. Maximum surge current capability (single pulse rated) shall be:
      a. Service entrance switchboard 300kA.
      b. Branch panelboards 150kA.
      c. Motor control centers 80kA.

2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	400V		400V
480Y/277	800V		800V

H. SPD shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ration of 50:1 using MIL STD. 220A methodology.

I. SPD shall be provided with 1 set of NO/NC dry contacts.

J. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Approve manufactures are:
1. Eaton Electrical.
2. Cutler Hammer CPS Series.
3. General Electric Tranquell Series.
4. Siemens TPS Series.
5. Square D Company XTE Series.
6. Current Technology.

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with NECA 5055.

3.02 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:
1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted:
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:
1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by engineer.

3. Light Switch: Install on lock side of doors.
4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:
   1. General:
      a. Measured to centerline of box.
      b. Where specified heights do not suit building construction or finish, mount as directed by Engineer.
   2. Light Switch: 48 inches above floor.
   3. Thermostat: 54 inches above floor.
   4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
   5. Wall Mounted Telephone Outlet: 52 inches above floor.
   6. Convenience Receptacle:
      a. General Interior Areas: 15 inches above floor.
      b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above countertops without splashback.
      c. Industrial Areas, Workshops: 48 inches above floor.
      d. Outdoor, All Areas: 24 inches above finished grade.
   7. Special-Purpose Receptacle: 54 inches above floor or as shown.

E. Install plumb and level.

F. Flush Mounted:
   1. Install with concealed conduit.
   2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
   3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install stainless steel mounting hardware in industrial areas.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

O. Box Type (Steel Raceway System):
   1. Exterior Locations:
      a. Exposed Raceways: Cast metal.
      b. Concealed Raceways: Cast metal.
      c. Concrete Encased Raceways: Cast metal.
      d. Class I, II, or III Hazardous Areas: Cast metal.
   2. Interior Dry Locations:
      a. Exposed Rigid Conduit: Cast metal.
      b. Concealed Raceways: Sheet steel.
      c. Concrete Encased Raceways: Cast metal.
      d. Lighting Circuits, Ceiling: Sheet steel.
      e. Class I, II, or III Hazardous Areas: Cast metal.
   3. Interior Wet Locations:
      a. Exposed Raceways: Cast metal.
      b. Concealed Raceways: Cast metal.
      c. Concrete Encased Raceways: Cast metal.
      d. Lighting Circuits, Ceiling: Sheet steel.
      e. Class I, II, or III Hazardous Areas: Cast metal.
   4. Cast-In-Place Concrete Slabs: Sheet steel.

P. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

Q. Box Type (Nonmetallic Raceway System):
   1. Corrosive Locations: Nonmetallic.
   2. Exposed Raceways: Nonmetallic.
   3. Concealed Raceways: Nonmetallic.
   4. Concrete Encased Raceways: Nonmetallic.

R. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC coated cast metal.

3.03 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of 3 right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:
   1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
   2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
   3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
   4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:
   1. Install with concealed conduit.
   2. Holes in surrounding surface shall be no larger than required to receive box.
   3. Make edges of boxes flush with final surface.

N. Mounting Hardware:
   1. Noncorrosive Interior Areas: Galvanized.
   2. All Other Areas: Stainless steel.

O. Location/Type:
   1. Finished, Indoor, Dry: NEMA 250, Type 1.
   2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
   3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
   5. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7 and Type 9, where indicated.
   6. Underground Conduit: Concrete Encased.
   7. Corrosive Locations: Nonmetallic.

3.04 WIRING DEVICES

A. Switches:
   1. Mounting Height: See Paragraph Outlet and Device Boxes.
   2. Install with switch operation in vertical position.
   3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:
   1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.

2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
    a. Install in cast metal box.
    b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

C. Multioutlet Surface Raceway System:
1. Install in accordance with manufacturer's instructions.
2. Wire alternate outlets to each circuit where two-circuit, 3-wire supply is shown.

3.05 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles.

F. Types (Unless Otherwise Shown):
1. Office: Stainless Steel.
2. Exterior: Weatherproof.
3. Interior:
    a. Flush Mounted Boxes: Stainless Steel.
    b. Surface Mounted, Cast Metal Boxes: Cast metal.
    c. Surface Mounted, Sheet Steel Boxes: Stainless Steel.
    d. Surface Mounted, Nonmetallic Boxes: Plastic.

3.06 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, Oiltight Type: Locations (Unless Otherwise Shown): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
1. Locations (Unless Otherwise Shown): Nonhazardous, outdoor, or normally wet areas.
2. Mounting: NEMA 250, Type 4X enclosure.

3.07 TERMINAL JUNCTION BOX

A. Install in accordance with Paragraph JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, nondestructible tag.

C. Do not install on finished outdoor surfaces.

D. Location:
   1. Finished, Indoor, Dry: NEMA 250, Type 1.
   2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
   3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.08 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.09 INDUSTRIAL CAPACITORS

A. Provide suitable hangers or mounting brackets for wall or ceiling mounting.

3.10 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moistureproof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and 3-phase units, 15 to 112 kVA.

3.11 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to installation, where applicable.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

3.12 MOTOR SURGE PROTECTION

A. Ground in accordance with NFPA 70.

B. Low Voltage: Ground terminals to equipment bus.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.
   2. American National Standards Institute (ANSI):
      a. C80.1, Rigid Steel Conduit-Zinc Coated.
      b. C80.3, Electrical Metallic Tubing-Zinc Coated.
   3. American Society for Testing and Materials (ASTM):
      a. A123 El, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
      b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
      b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
      c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
      d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.
   6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Safety Flexible Metal Conduit.
      b. 6, Standard for Safety Rigid Metal Conduit.
      c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.
      d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.
      e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
      f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.
      g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.
      h. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.
      i. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's Literature:
      a. Rigid galvanized steel conduit.

b. PVC Schedule 40 and schedule 80 conduit.
c. PVC-coated rigid galvanized steel conduit.
d. Flexible metal, liquid-tight conduit.
e. Flexible, nonmetallic, liquid-tight conduit.
f. Conduit fittings.
g. Wireways.

2. Precast Manholes and Handholes:
   a. Dimensional drawings and descriptive literature.
   b. Traffic loading calculations.
   c. Accessory information.
3. Conduit Layout:
   a. Plan and section type, showing arrangement and location of conduit required for:
      1) Low voltage feeder and branch circuits.
      2) Instrumentation and control systems.
      3) Communications systems.
      4) Empty conduit for future use.
   b. Reproducible drawings; scale not greater than 1/2 inch equals 1 foot.
      1) Equipment and machinery proposed for bending metal conduit.
      2) Method for bending PVC conduit less than 30 degrees.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):
   1. Meet requirements of ANSI C80.1 and UL6.
   2. Material: Hot-dip galvanized, with chromated protective layer.

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

C. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of NEMA RN 1.
   2. Material:
      a. Conduit: Meet requirements of ANSI C80.1 and UL 6
      b. PVC Coating: 40 mils nominal thickness, bonded to metal.

D. Flexible Metal, Liquid-Tight Conduit:
   1. UL 360 listed for 105 degrees C insulated conductors.
   2. Material: Galvanized steel, with an extruded PVC jacket.

E. Rigid Aluminum Conduit:
   1. Meet requirements of ANSI C80.5 and UL 6.
   2. Material: Type 6063, copper-free aluminum alloy.

F. Flexible, Nonmetallic, Liquid-Tight Conduit:
   1. Material: PVC core with fused flexible PVC jacket.
   2. UL 1660 listed for:
      a. Dry Conditions: 80 degrees C insulated conductors.
      b. Wet Conditions: 60 degrees C insulated conductors.
   3. Manufacturers:
      a. Carlon; Carflex or X-Flex.
      b. T & B; Xtraflex LTC or EFC.

2.02 FITTINGS

A. Rigid Galvanized Steel Conduit:
   1. General:
      a. Meet requirements of UL 514B.
      b. Type: Threaded, galvanized. Set screw fittings not permitted.
   2. Bushing:
      a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
      b. Manufacturers:
         1) Thomas & Betts; Type BIM.
         2) O.Z./Gedney; Type HB.
   3. Grounding Bushing:
      a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
      b. Manufacturers:
         1) Appleton; Series GIB.
         2) O.Z./Gedney; Type HBLG.
   4. Conduit Hub:
      a. Material: Malleable iron with insulated throat.
      b. Manufacturers:
         1) O.Z./Gedney; Series CH.
         2) T & B; Series 370.
   5. Conduit Bodies:
      a. Material: Malleable iron, sized as required by NFPA 70.
      b. Manufacturers (For Normal Conditions):
         1) Appleton; Form 35 threaded Unilets.
         2) Crouse-Hinds; Form 7 or 8 threaded condulets.
         3) Killark; Series O Electrolets.
      c. Manufacturers (For Hazardous Locations):
         1) Appleton.
         2) Crouse-Hinds.
         3) Killark.
   6. Couplings: As supplied by conduit manufacturer.
   7. Conduit Sealing Fitting Manufacturers:
      a. Appleton; Type EYF, EYM, or ESU.
      b. Crouse-Hinds; Type EYS or EZS.
      c. Killark; Type EY or EYS.

8. Drain Seal Manufacturers:
    a. Appleton; Type SF.
    b. Crouse-Hinds; Type EYD or EZD.
9. Drain/Breather Fitting Manufacturers:
    a. Appleton; Type ECDB.
    b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers:
    a. Deflection/Expansion Movement:
        1) Appleton; Type DF.
        2) Crouse-Hinds; Type XD.
    b. Expansion Movement Only:
        1) Appleton; Type XJ.
        2) Crouse-Hinds; Type XJ.
11. Cable Sealing Fittings:
    a. To form watertight non-slip cord or cable connection to conduit.
    b. For Conductors With OD of 1/2 Inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers:
        1) Crouse-Hinds; CGBS.
        2) Appleton; CG-S.

B. PVC Conduit and Tubing:
1. Meet requirements of NEMA TC-3.
2. Type: PVC, slip-on.

C. PVC-Coated Rigid Galvanized Steel Conduit:
1. Meet requirements of UL 514B.
2. Type: Rigid galvanized steel, PVC coated by conduit manufacturer.
3. Overlapping pressure sealing sleeves.
4. Conduit Hangers, Attachments, and Accessories: PVC-coated.

D. Flexible Metal, Liquid-Tight Conduit:
1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Long design type extending outside of box or other device at least 2 inches.
4. Manufacturer: T & B; Series 5300.

E. Flexible, Nonmetallic, Liquid-Tight Conduit: Meet requirements of UL 514B.
1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
2. Manufacturers:
    a. Carlon; Type LT.
    b. Kellems; Polytuff.
    c. T & B; LT Series.

F. Watertight Entrance Seal Device:
1. New Construction:
    a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
    b. Manufacturer: O.Z./Gedney; Type FSK or WSK, as required.

2. Gored-Hole Application:
    a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
    b. Manufacturer: O.Z./Gedney; Series CSM.

G. Hazardous Locations: Approved for use in the atmosphere involved.
    1. Manufacturer: Crouse-Hinds; Type ECGJH.

H. Corrosive Locations:
    1. Material: 40-mil PVC-coated rigid steel.
    2. Manufacturers:
        a. Robroy Industries.
        b. Carlon.
        c. Crouse-Hinds.

2.03 WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Outdoor rain-tight if outdoor, and indoor if indoor.

D. Finish: Gray, baked enamel.

E. Manufacturers:
    1. Square D.
    2. B-Line Systems, Inc.

2.04 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access adapters between top of manhole and finished grade at required elevations.

D. Drainage:
    1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
    2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:
    1. Provide on all four sides.
    2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
    3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:
   1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
   2. Location:
      a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
      b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:
   1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
   2. Wall Attachment:
      a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
      b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
      c. Arrange so that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:
   1. Material: Machined cast iron.
   2. Diameter: 32 inches.
   3. Cover Type: Indented, solid top design, with two drop handles each.
   4. Cover Loading: AASHTO Division I, H-20.
   5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
      a. Above 600 Volts: ELECTRIC HV.
      b. 600 Volts and Below: ELECTRIC LV.
      c. TELEPHONE.
      d. Instrumentation: SIGNAL.

I. Manhole/handhole Frames and Covers:
   1. Material: Steel, hot-dipped galvanized.
   2. Cover Type: Solid, bolt-on, of checkered design.
   3. Cover Loading: H-20.
   4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
      a. 600 Volts and Below: ELECTRIC LV.
      b. TELEPHONE.
      c. Instrumentation: SIGNAL.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:
   1. U.S. Precast.
   2. Brooks Products, Inc.
   3. Penn-Cast Products, Inc.
   4. Concrete Conduit Co.
   5. Associated Concrete Products, Inc.
   6. Utility Vault Co.

7. Pipe, Inc.

2.05 ACCESSORIES

A. Duct Bank Spacers:
   1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
   2. Suitable for all types of conduit.
   3. Manufacturer: Underground Device, Inc.; Type WUNPEECE.

B. Identification Devices:
   1. Raceway Tags:
      a. Material: Permanent, nylon.
      b. Shape: Round.
      c. Raceway Designation: Pressure stamped, embossed, or engraved.
      d. Tags relying on adhesives or taped-on markers not permitted.
   2. Warning Tape:
      a. Material: Polyethylene, 4-mil gauge.
      b. Color: Red.
      c. Width: Minimum 6-inch.
      d. Designation: Warning on tape that electric circuit is located below tape.
      e. Manufacturers:
         1) Blackburn, Type RT.
         2) Griffolyn Co.
   3. Buried Raceway Marker:
      a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where change direction runs.
      b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES, in letters 1/4-inch high.
      c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Raceway Coating:
   1. Material: Bitumastic or plastic tape coating.
   2. Manufacturers:
      a. Koppers bitumastic; No. 505.
      b. Scotchwrap; No. 51, plastic tape.

D. Wraparound Duct Band:
   1. Material: Heat-shrinkable, cross-linked polyolefin, pre-coated with hot-melt adhesive.
   2. Manufacturer: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120, CONDUCTORS, concerning conduit sizing for aluminum conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

H. Group raceways installed in same area.

I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

L. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

M. Install watertight fittings in outdoor, underground, or wet locations.

N. Paint threads, before assembly of fittings, of galvanized conduit installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

O. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

P. Do not install raceways in concrete equipment pads, foundations, or beams.

Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 1-1/2 inches.

B. Provide support during placement of concrete to ensure raceways remain in position.

C. Floor Slabs:
   1. Outside diameter of conduit not to exceed one-third of the slab thickness.

2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.03 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed:
   1. Rigid Aluminum.

C. Interior, Exposed:
   1. Rigid Aluminum.
   2. Electric metallic tubing for ceiling portion of lighting circuits in a conditioned environment.

D. Interior, Concealed (Not Embedded in Concrete):
   1. Rigid Aluminum.

E. Direct Earth Burial: PVC Schedule 80.

F. Concrete-Encased Raceways: PVC Schedule 40.

G. Under Slabs-On-Grade: PVC Schedule 40.

H. Corrosive Areas, Exterior: PVC-coated rigid galvanized steel.

I. Corrosive Areas, Interior: PVC-coated rigid galvanized steel.

J. Lightning Protection: PVC Schedule 40.

3.04 CONNECTIONS

A. For motors, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
   1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.
   2. Conduit Size Over 4 Inches: Nonflexible.
   3. Corrosive Areas: Flexible, nonmetallic, liquid or PVC-coated metallic, liquid-tight.
   4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, non-liquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas required being Oil tight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground or Concrete Embedded to Exposed: PVC Coated Rigid galvanized steel conduit.

E. Under Equipment Mounting Pads: Rigid galvanized steel conduit.

F. Exterior Light Pole Foundations: Rigid galvanized steel conduit.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide non-shrink grout dry-pack, or use watertight seal device.

F. Entering Structures:
   1. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   2. Concrete Roof or Membrane Waterproofed Wall or Floor:
      a. Provide a watertight seal.
      b. Without Concrete Encasement: Install watertight entrance seal device on each side.
      c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
      d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
      e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
   3. Heating, Ventilating, and Air Conditioning Equipment:
      a. Penetrate equipment in area established by manufacturer.
      b. Terminate conduit with flexible metal conduit at junction box or condulets attached to exterior surface of equipment prior to penetrating equipment.
      c. Seal penetration with silicone type sealant.
   4. Corrosive-Sensitive Areas:
      a. Seal all conduit entering field panels containing electronic equipment.
      b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
      c. Seal penetration with silicone type sealant.
   5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
   6. Non-waterproofed Wall or Floor (Underground, without Concrete Encasement):
      a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
      b. Fill space between raceway and sleeve with an expandable plastic compound on each side.
   7. Manholes and Pullboxes:
      a. Metallic Raceways: Provide insulated grounding bushings.
      b. Nonmetallic Raceways: Provide bell ends flush with wall.

c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

C. Provide and attach wall brackets or strap hangers:
   1. Wood: Wood screws.
   2. Hollow Masonry Units: Toggle bolts.
   3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
   4. Steelwork: Machine screws.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:
   1. Bends 30-Degree and Larger: Provide factory-made elbows.
   2. 90-Degree Bends: Provide rigid steel elbows.
   3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

A. Solvent Welding:
   1. Provide manufacturer recommended solvent; apply to all joints.
   2. Install such that joint is watertight.

B. Adapters:
   1. PVC to Metallic Fittings: PVC terminal type.
   2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belied-End Conduit: Bevel the un-belled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:
   1. Rigid Galvanized Conduit:
      a. Provide one lock nut each on inside and outside of enclosure.
      b. Install grounding bushing.
      c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
      d. Install insulated bushing on ends of conduit where grounding is not required.
      e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   2. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.

3. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
4. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
5. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.13 UNDERGROUND RACEWAYS

A. This section applies to all underground conduit installations including underground installation on open field, under the slab, under the roadways, etc.

B. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

C. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

D. Make routing changes as necessary to avoid obstructions or conflicts.

E. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

F. Union type fittings not permitted.

G. Spacers:
1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

H. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

I. Installation with Other Piping Systems:
1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

K. Concrete Encasement: As specified in Section 03300, CAST-IN-PLACE CONCRETE.
1. Concrete Color: Gray, dust top of concrete ductbank with powdered red concrete dye before concrete sets and trowel dry onto top of ductbank.

L. Backfill:
   1. Do not backfill until inspected by Engineer.

3.14 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade back to original state.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in GROUNDING section.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.15 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.16 IDENTIFICATION DEVICES

A. Raceway Tags:
   1. Identify origin and destination.
   2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
   3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:
   1. Install at grade to indicate direction of underground raceways.
   2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
   3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.17 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

END OF SECTION

SECTION 16120

CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American Society for Testing and Materials (ASTM):
      a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-Plated Steel Plate, Sheet, and Strip.
      b. B3, Standard Specification for Soft or Annealed Copper Wire.
      c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      d. B263, Standard Test Method for Determination of Cross- Sectional Area of Stranded Conductors.
   2. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test with a Theoretical Heat Input of 210,000 Btu/hour.
   3. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.
   4. National Electrical Manufacturers' Association (NEMA):
      a. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      b. WC 7, Crosslinked-Thermosetting-Polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      c. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      d. WC 55, Instrumentation Cables and Thermocouple Wire.
   5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL):
      a. 13, Standard for Safety Power-Limited Circuit Cables.
      b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
      c. 62, Standard for Safety Flexible Cord and Fixture Wire.
      d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.
      e. 510, Standard for Safety Insulating Tape.
      f. 854, Standard for Safety Service-Entrance Cables.
      g. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
      h. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
      i. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Shop Drawings:
   1. Wire and cable descriptive product information.
   2. Wire and cable accessories descriptive product information.

B. Quality Control Submittals:
   1. Certified Factory Test Report for conductors 600 volts and below.
   2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:
   1. 480V power circuits: stranded copper.
   2. 120-Volt power circuits, No. 10 AWG and smaller: stranded copper.
   3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN for No. 6 AWG and smaller. XHHW for No.4 AWG and larger, or installations in wet locations.

D. Direct Burial and Aerial Conductors and Cables:
   1. Type USE/RHH/RHW insulation, UL t(54 listed, Type RHW-2/USE-2.
   2. Conform to physical and minimum thickness requirements of NEMA WC 3.

E. Flexible Cords and Cables:
   1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.
   2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.02 600-VOLT RATED CABLE

A. General:
   1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
   2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
   3. Suitable for installation in open air, in cable trays, or conduit.

4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Wire and Connectors:
1. Cable shall be rated for 600 volts and shall meet the requirements below:
2. Conductors shall be stranded.
3. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
4. Type of wire shall be XHHW or THHN, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.
5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
6. Conductor metal shall be copper.
7. All conductors shall be meg-ohm tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type I-Multiconductor Control Cable:
1. Conductors:
   a. No. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-I.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. General Cable.
   c. Southwire.

D. Type 2-Multiconductor Power Cable:
1. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically crosslinked ethylene-propylene with CPE jacket.
   c. UL 1581 listed as Type EPR, rated VW-1.

d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC74 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.

2. Cable shall pass the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2 3 4	0.54 0.58 0.63	60 60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60
4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:
   a. Okonite Co.
   b. General Cable.
   c. Southwire.

E. Type B-No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements. Insulation shall be rated for 600V, 300V insulation is not acceptable.
   1. Outer Jacket: 45-mil nominal thickness.
   2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   3. Dimension: 0.31-inch nominal OD.

4. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    b. 20 AWG, seven-strand tinned copper drain wire.
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nominal nylon.
    e. Color Code: Pair conductors black and red.
5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.
    c. General Cable.
6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.
    a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than +2 ohms from the calculated average loop resistance valve.
    b. Insulation resistance tests shall be performed by using a 500 volt megohmeter to measure the insulation resistance between each channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

F. Type B1-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements. Insulation shall be rated for 600V, 300V insulation is not acceptable.
    1. Outer Jacket: 45-mil nominal.
    2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
    3. Dimension: 0.32-inch nominal OD.
    4. Conductors:
        a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
        b. 20 AWG, seven-strand, tinned copper drain wire.
        c. Insulation: 15-mil nominal PVC.
        d. Jacket: 4-mil nylon.
        e. Color Code: Triad conductors black, red, and blue.
    5. Manufacturers:
        a. Okonite Co.
        b. Alpha Wire Corp.
        c. General Cable.

G. Type B2-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements. Insulation shall be rated for 600V, 300V insulation is not acceptable.
   1. Conductors:
      a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
      b. Tinned copper drain wires.
      c. Pair drain wire size AWG 20, group drain wire size AWG 18.
      d. Insulation: 15-mil PVC.
      e. Jacket: 4-mil nylon.
      f. Color Code: Pair conductors black and red with red conductor numerically printed for group identification.
      g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
   2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
   3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

   4. Manufacturers:
      a. Okonite Co.
      b. Alpha Wire Corp.
      c. General Cable.
      d. Belden.

H. Type B3-No. 18 AWG, Multi-twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 55. Insulation shall be rated for 600V, 300V insulation is not acceptable.
   1. Conductors:
      a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
      b. Tinned copper drain wire size 18 AWG
      c. Insulation: 15-mil nominal PVC.
      d. Jacket: 4-mil nylon.
      e. Color Code: Pair conductors black and red, with red conductor numerically printed for group identification.
   2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

3. Cable Sizes:

Number Of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.46	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.06	80
36	1.21	80
50	1.42	80

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

I. Variable Frequency Drive (VFD) Output Power Cable:
   1. Section applies to power cables routed between the output of VFDs and motor terminals.
   2. Cable shall be rated for 600 volts type VFD rated and shall meet the requirements below:
      a. Conductors shall be stranded copper.
      b. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
      c. Type of wire shall be XLPE rated 90 degrees Celsius suitable for wet locations.
      d. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
      e. Cable construction shall consist of three insulated current-carrying phase conductors and three bare ground conductors, symmetrically placed between the phase conductors, and twisted beneath a continuous copper tape shield and overall polymeric jacket.
   3. Each ground conductor size (circular mil area) shall be 1/3 of the NEC required size (circular mil area) for a single ground conductor. If one third of the required circular mil area does not correspond to a standard size (circular mil area) of construction, the next largest size of standard construction shall be us All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.
   4. Manufacturers:
      a. Southwire-.
      b. Belden.
      c. Approved Equal.

J. Ethernet Cat. 6e UTP Cable (Copper):
   1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.

2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 23 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.235 inch. Operating Temperature Range: -20'C to +75'C. Model Number – 7881A, Belden Inc.
3. NEC/UL specification CMR, UL444, UL verified category 6.
4. Manufacturer:
    a. Belden Inc.
    b. Or equal.

2.03 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

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

B. Identification Devices:
1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:
1. Nylon, Self-Insulated Crimp Connectors:
    a. Manufacturers and Products:
        1) Thomas & Betts; Sta-Kon.
        2) Burndy; Insulink.
        3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
    a. Manufacturers and Products:
        1) Thomas & Betts; Sta-Kon.
        2) Burndy; Insulink.
        3) ILSCO.

D. Cable Lugs:
1. In accordance with NEMA CC I.
2. Rated 600 volts of same material as conductor metal.

3. Insulated, Locking-Fork, Compression Lugs:
    a. Manufacturers and Products:
        1) Thomas & Betts; Sta-Kon.
        2) ILSCO; ILSCONS.
4. Un-insulated Crimp Connectors and Terminators:
    a. Manufacturers and Products:
        1) Square D; Versitide.
        2) Thomas & Betts; Color-Keyed.
        3) ILSCO.
5. Un-insulated, Bolted, Two-Way Connectors and Terminators:
    a. Manufacturers and Products:
        1) Thomas & Betts; Locktite.
        2) Burndy; Quiklug.
        3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.
    1. Manufacturers and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.
    1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

2.05 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:
    1. Ideal Co.; Yellow 77.
    2. Polywater, Inc.
    3. Cable Grip Co.

2.06 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.07 FIBER OPTIC DATA CABLE AND ACCESSORIES

A. The fiber optic cable shall be a three-fiber outdoor type cable suitable for installation and pulling through a duct bank. For simple point to point fiber optic link, the cable shall be six fiber 62.5/125 microns as manufactured by Belden Wire and Cable Company, Catalog No. 225716, or approved equal.

B. Furnish compatible connectors and breakout kits with the cable. Furnish sufficient connectors and breakout kits to meet the project requirements and install connectors on all fiber optic cable. Use Contract Drawings as a guide in determining lengths, taking into account actual field conditions. Use the fiber optic connectors, termination kits, and cable test kits per cable manufacturer that is compatible with specified data concentrators.

2.08 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

2.09 ACCESS CONTROL CABLES

A. 2C/ 18 AWG shielded communication plenum cable. Match model with existing.

B. 6C/ 18 AWG shielded communication plenum cable. Match model with existing.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in pullboxes, and other indicated locations, are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

I. Cable Tray Installation:
   1. Install wire and cable parallel and straight in tray.

2. Bundle, in groups, all wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
3. Clamp cable bundles prior to making end termination connections.
4. Separate cables of different voltage rating in same cable tray with barriers.
5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
   a. Horizontal Runs: 20 feet.
   b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:
   1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
   2. No. 8 AWG and Smaller: Provide colored conductors.
   3. Colors:

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

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

3.03 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, hand holes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:
   1. Assign circuit name based on device or equipment at load end of circuit.

2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:
   1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
   2. Cables, and Conductors No. 2 AWG and Larger:
      a. Identify with marker plates.
      b. Attach marker plates with nylon tie cord.
   3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring.

B. Connections and Terminations:
   1. Install wire nuts only on solid conductors.
   2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
   3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
   4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
   5. Install un-insulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.
   6. Tape insulates all un-insulated connections.
   7. Place no more than one conductor in any single-barrel pressure connection.
   8. Install crimp connectors with tools approved by connector manufacturer.
   9. Install terminals and connectors acceptable for type of material used.
   10. Compression Lugs
      a. Attach with a tool specifically designed for purpose.
      b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.
      c. Do not use plier-type crimpers.

C. Do not use soldered mechanical joints.

D. Splices and Terminations:
   1. Indoors: Use general purpose, flame retardant tape.
   2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

E. Cap spare conductors and conductors with UL listed end caps.

F. Cabinets, Panels, and Motor Control Centers:
   1. Remove surplus wire, bridle and secure.
   2. Where conductors pass through openings or over edges in sheet metal, remove bums, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

G. Control and Instrumentation Wiring:
   1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
   2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
   3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
   4. Cable Protection:
      a. Under Infinite Access Floors: May be installed without bundling.
      b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
      c. Maintain integrity of shielding of instrumentation cables.
      d. Ensure grounds do not occur because of damage to jacket over the shield.

H. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

I. Variable Frequency Drive (VFD) Output Power Cable:
   1. Install cables in raceway.
   2. Terminate the three ground conductors together at the motor and at the ground bus of the VFD.
   3. Terminate aluminum armor at motor and at VFD. At motor, terminate shield with cable manufacturer recommended termination kit. Termination shall be to the motor junction box. At the VFD, terminate armor to the inverter drive frame. The termination kit must provide a 360-degree connection of the armor to frame and motor junction box.
   4. Cable armor and ground conductors shall be made continuous through disconnects or splice boxes where un-grounded conductors are terminated on a terminal block or cable lug. Use manufacturer recommended shield termination kits and connect pigtails together. The cable shield shall not be connected to the disconnect switch or box enclosure.

3.05 CONDUCTORS ABOVE 600 VOLTS

A. Do not splice unless specifically indicated or approved by the Engineer.

B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer's instructions

C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer non-tracking insulation tubing, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing, plus a ground braid and clamp.

E. Install terminals or connectors acceptable for type of conductor material used.

F. Provide outdoor rain skirts for all riser pole and outdoor switchgear terminations.

G. Provide shield termination and grounding for all terminations.

H. Provide necessary mounting hardware, covers, and connectors.

I. Where elbow connectors are specified, install in accordance with manufacturer's instructions.

J. Connections and Terminations:
   1. Install un-insulated crimp connectors and terminators for power circuit conductors No. 4 AWG through No. 2/0 AWG.
   2. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
   3. Install un-insulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.
   4. Insulate bus connections with heat shrinking tubing, tape, and sheets.
   5. Make all bus connections removable and reusable in accordance with manufacturer’s instructions.

K. Give 2 working days' notice to ENGINEER prior to making splices or terminations.

3.06 CONDUCTOR ARC AND FIREPROOFING

A. Install arc and fireproofing, tape on 600-volt single conductors and cables except those rated Type TC in manholes, hand holes, vaults, cable trays, and other indicated locations.

B. Install arc and fireproofing tape on 25 kV cables throughout their entire exposed length in manholes, hand holes, vaults, cable trays, and other indicated locations.

C. Wrap conductors of same circuit entering from separate conduit together as a single cable.

D. Follow tape manufacturer's installation instructions.

E. Secure tape at intervals of 5 feet with bands of tape binder. Each tape band shall consist of a minimum of two wraps directly over each other.

3.07 UNDERGROUND DIRECT BURIAL CABLE

A. Install in trench as required.

B. Warning Tape: Install approximately 12 inches above cable, aligned parallel to, and within 12 inches of centerline of the run.

3.08 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:
   1. Inspect Each Individual Exposed Power Cable No. 6 and Larger for:
      a. Physical damage.
      b. Proper connections in accordance with single-line diagram.

c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
d. Color coding conformance with specifications.
e. Proper circuit identification.

2. Mechanical Connections for:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables for:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables for:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:
1. Insulation Resistance Tests:
   a. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
   b. Evaluate ohmic values by comparison with conductors of same length and type.
   c. Investigate values less than 50 megohms.
   d. Utilize 1,000V dc megohmmeter for 600V insulated conductors.
2. Continuity test by ohmmeter method to ensure proper cable connections.

END OF SECTION

SECTION 17304

INSTRUMENTATION

PART 1 GENERAL

1.01 GENERAL INFORMATION AND DESCRIPTION

A. This specification is intended to give a general description of what is required, but does not cover all details which will vary in accordance with the requirements of the equipment furnished. It is, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all powered and unpowered instruments and appurtenances whether specifically mentioned in the specification or not.

B. Instruments shall be furnished and installed with all necessary accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. Installations shall incorporate the highest standards for the type of service shown on the Drawings including loop testing of the entire installation and instruction of operating personnel in the care, operation, calibration and maintenance of all instrumentation.

C. All instrumentation shall be of first-class workmanship and shall be entirely designed and suitable for the intended services. All materials used in fabricating the equipment shall be new and undamaged.

1.02 SCOPE

A. The Contractor shall provide, through the services of a single instrumentation and control system integrator, (instrumentation subcontractor) all components, system installation services, as well as, all required and specified ancillary services in connection with the Plant Instrumentation Control and Monitoring System. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, program, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified in the contract drawings. The single instrumentation and control system integrator shall complete the detailed design of the Plant Instrumentation Control and Monitoring System. The system shall include all measuring elements, signal converters, transmitters, digital hardware and software, signal and data transmission systems, interconnecting wiring, brackets, supports, piping, tubing, valves, mounting hardware, and such accessories as shown, specified, and/or required to provide the functions indicated and a complete working system in place.

B. The scope of the work to be performed includes, but is not limited to, the following:
   1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.
   2. The Contractor shall retain a single instrumentation and control system integrator who shall furnish all services and equipment defined herein and in other Specification sections as listed below under related work.

3. Furnish and install all digital control system hardware as specified herein.
4. Furnish and install process instrumentation and associated taps, nipples, valves, tubing, and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
5. Final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under this Division.
6. Furnish and install surge protective device systems for all digital equipment, data communications equipment, local control panels, and field instruments provided under this Division, including connections to grounding system(s) provided under Division 16.
7. Coordinate grounding requirements with the Electrical Contractor for all digital equipment, local control panels, and field instrumentation provided under this Division. Terminate grounding system cables at all equipment provided under this Division.
8. Application Software and Programming of the PLC and SCADA will be provided by Owner Programming Consultant and it is not part of this contract. Work related to support this activity and it is part of this contract includes:
    a. Demonstration testing at the site.
    b. Assistance with onsite checkout of applications software and startup.
    c. Participate and assist to Owner Programming Consultant in control and instrument loop checks to verify and ensure proper loop operation from all HMI and SCADA screens to the physical instrument or control device.
9. Provide system testing, calibration, and startup services as specified herein and as required to make all systems fully operational.
10. Furnish operator training services as described herein. Coordinate with the Owner for the number of training classes required and times.

C. Furnish and install embedded supports, instrument stands, brackets, mounting hardware, piping, tubing, isolation valves and related items required for instrumentation and equipment furnished under Division 17.

D. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.03 UNPOWERED INSTRUMENTS

A. The Instrumentation and Control System Integrator shall furnish, install, test and place in operation process instrumentation as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process controls as shown on the Drawings and as specified. The Contractor may elect to install primary elements on process lines provided that the Instrumentation and Control System Integrator provides full on-site supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Instrumentation and Control Integrator shall supervise installation of equipment provided under this Division where installation is provided by others.

C. Tappings and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and tappings for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

D. Unless otherwise specified, instruments shall be provided with enclosures to suit specified environmental conditions. Field-mounted devices shall be rugged and mounted on walls or pipe stanchions.

1.04 POWERED INSTRUMENTS

A. The Instrumentation and Control System Integrator shall furnish, install, test and place in operation powered process instrumentation (level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process control system as shown on the Drawings and as specified. Powered instruments are those instruments which require power (120 VAC or 24 VDC loop power) to operate. The Contractor may elect to install primary elements on process lines provided that the Instrumentation and Control Integrator provides full on-site supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Instrumentation and Control Integrator shall supervise installation of equipment provided under this Division where installation is provided by others.

C. Tappings and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and tappings for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

PART 2 PRODUCTS

2.01 INSTRUMENTATION GENERAL

A. Type:

1. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water industry. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required
2. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mA dc (milliampere direct current), however, signals between instruments within the same panel or cabinet may be 1-5V dc (volts direct current), or the like.
3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed.
4. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Electrical Drawings, to comply with the National Electrical Code.
5. All indicators and recorder readouts shall be linear in process units, unless otherwise noted.
6. All transmitters shall be provided with integral indicators as shown on drawings.
7. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
8. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, as much as reasonably possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.
9. Unless otherwise specified, field instrument and power supply enclosures shall be 316- stainless steel, fiberglass or PVC coated copper free cast aluminum NEMA 4X construction.
10. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.
11. All cables provided under this section shall be rated for environment. Wet locations shall include conduits systems below grade rated.

B. Electrical:
   1. All non-loop powered equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 117 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplied required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
   2. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.
   3. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

2.02 INSTRUMENTS

A. F1 Flow Element and Transmitter, Electromagnetic:
   1. General:
      a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
      b. Type:
         1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
         2) Full bore meter with magnetic field traversing entire flow-tube cross section.
         3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
      c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
   2. Service:
      a. Stream Fluid:
         1) As noted.
         2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
      b. Flow Stream Descriptions: If and as described below.
   3. Operating Temperature:
      a. Element:
         1) Ambient: Minus 5 to 140 degrees Fahrenheit, typical, unless otherwise noted.
         2) Process: Minus 5 to 140 degrees Fahrenheit, typical, unless otherwise noted.
      b. Transmitter:
         1) Ambient: Minus 5 to 140 degrees Fahrenheit, typical, unless otherwise noted.
         2) Storage: 15 to 120 degrees Fahrenheit, typical, unless otherwise noted.
   4. Performance:
      a. Flow Range: As noted.
      b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.

c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.

5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.
6. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
   a. Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.
   b. Liner Material:
      1) Teflon, unless otherwise noted.
      2) For potable water service, must have appropriate approvals.
   c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
   d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
   e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
   f. Grounding Ring:
      1) Required, unless otherwise noted.
      2) Quantity: Two, unless otherwise noted.
      3) Material: Type 316 stainless steel, unless otherwise noted.
   g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
   h. Submergence:
      1) Temporary: If noted.
      2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
   i. Direct Buried (3 to 10 feet): If noted.
   j. Hazardous Area Certification:
      1) Class 1, Division 2, Groups A, B, C, D: If noted.
      2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
      3) Class 1, Division 1, Groups C, D, and FM approved: If noted.
9. Transmitter:
   a. Mounting: Surface (wall), unless otherwise noted.
   b. Display: Required, unless otherwise noted.
      1) Digital LCD display, indicating flow rate and total.
      2) Bi-directional Flow Display: Required, unless otherwise noted.
         a) Forward and reverse flow rate.
         b) Forward, reverse and net totalization.
   c. Parameter Adjustments: By keypad or non-intrusive means.
   d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
   e. Empty Pipe Detection:
      1) If noted.

2) Drives display and outputs to zero when empty pipe detected.

10. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
        2) Supports Superimposed Digital HART protocol: If noted.
    b. Discrete Outputs: If noted.
        1) Two discrete outputs, typical, rated for up to 30 volts, typical.
        2) Programmable as noted for the following typical parameters:
            a) Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.
    c. Discrete Input: If noted.
        1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
    d. Communication: If noted.
        1) Ethernet IP or Modbus TCP communication as noted on drawings.
11. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
12. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
        3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
        4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Factory Ready for Future In situ Verifications: If noted.
    a. Original meter parameter values available from vendor by request.
15. Accessories:
    a. In situ Verification System: If noted.
        1) Quantity: One complete system provided for the project.
        2) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
        3) Physical access to the flow-tube not required.
        4) Meet standards established by the National Testing Laboratory.
        5) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
        6) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
        7) Windows-based software.
    b. Primary Simulation System: If noted.
        1) Quantity: One complete system provided for the project.

2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
    a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
    b) Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
    c) Switch selectable for forward, reverse and zero flow rate.
3) Verifies various input and output signals.

c. Spool Piece: Provide spool to match process pipe material and size for insertion into pipe line during meter maintenance or replacement, as noted.

16. Manufacturers, or Equal:
    a. Endress+Hauser W400 or L400 Magnetic Flow Meter.

2.03 INSTRUMENT LIST

TAG NO.	COMPONENT CODE	COMPONENT TITLE	RANGE	P&I DWG	REMARKS
FIT-1611	F1	TOTAL PERMEATE SIDESTREAM FLOW SUFLURIC ACID INJECTION	0 – 100 GPM	I01	LINE SIZE: 3" (REFER TO DRAWING M04)

PART 3 EXECUTION

3.01 INSTALLATION – UNPOWERED INSTRUMENTS

A. Equipment shall be located so that it is accessible for operation and maintenance. The Instrumentation and Control Integrator shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

B. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square 1/2-inch thick aluminum base plate unless shown adjacent to a wall or otherwise noted. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

C. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

D. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel constructions.

E. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

3.02 INSTALLATION – POWERED INSTRUMENTS

A. General:
   1. Equipment shall be located so that it is accessible for operation and maintenance. The Instrumentation and Control Integrator shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support:
   1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square 1/2-inch thick aluminum base plate unless shown adjacent to a wall or otherwise noted. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.
   2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.
   3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel constructions.
   4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.
   5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring: Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.03 ADJUSTMENT AND CLEANING

A. The Instrumentation and Control Integrator shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Owner, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Owner of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

B. The Instrumentation and Control Integrator shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Owner, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

C. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Owner a detailed description, in duplicate, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

3.04 FIELD INSTRUMENT CALIBRATION REQUIREMENTS

A. Field Instrument Calibration Requirements:
   1. The Instrumentation and Control Integrator shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.
   2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Institute for Standards and Technology (NIST).
   3. The Instrumentation and Control Integrator shall provide a written calibration sheet to the Owner for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Owner approval prior to the start of calibration. This sheet shall include but be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.
   4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Owner.
   5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the Instrumentation and Control Integrator shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

END OF SECTION