



COLLIER COUNTY

**NORTHEAST WATER RECLAMATION FACILITY/WATER TREATMENT PLANT
DEEP INJECTION WELLS CONVEYANCE**

CLIENT PROJECT NO. 70194.2

CONTRACT/TECHNICAL SPECIFICATIONS

ISSUE FOR CONSTRUCTION

VOLUME 1 OF 2

DECEMBER 2025



COLLIER COUNTY
NORTHEAST WATER RECLAMATION FACILITY/WATER TREATMENT PLANT
DEEP INJECTION WELLS

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COLLIER COUNTY WATER-SEWER DISTRICT UTILITIES STANDARDS MANUAL

**SECTION
NO**

TITLE

2

TECHNICAL SPECIFICATIONS

SECTION 01_11_00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. The Work includes the construction of a 36-in HDPE Deep Injection Irrigation Quality (DIIQ) conveyance line and above ground piping and appurtenances for two existing Class 1 deep injection wells (DIWs) and one dual zone monitoring well (DZMW). These DIWs will be utilized to dispose of Irrigation Quality (IQ) water from a water reclamation facility, Membrane Softening (MS) concentrate, and reverse osmosis (RO) concentrate from a water treatment plant (WTP). Above ground DIW features include a well annulus pressure system. Electrical and instrumentation and control (I&C) features of the project are included in the Work. All improvements shall be constructed in accordance with the Drawings and Specifications.
- B. Except as specifically noted, the Contractor shall provide and pay for:
 - 1. Labor, materials, tools, construction equipment, and machinery.
 - 2. Other facilities and services necessary for proper execution and completion of the work.
- C. The Contractor shall comply with all codes, ordinances, rules, regulations, orders, and other legal requirements of the Collier County, local community jurisdiction, and FDEP.
- D. Location of Utilities:
 - 1. Information shown on the drawings as to the location of existing utilities has been prepared from the most reliable data available; however, this information is not guaranteed, and it shall be the Contractor's responsibility to determine the location, character, and depth of any existing utilities and may require soft digs. Extreme caution shall be exercised to eliminate any possibility of any damage to utilities resulting from his activities. The Contractor shall be fully responsible for any damage to utilities resulting from their operation.
 - 2. The Contractor shall determine any conflicts between existing utilities, or other structures or facilities, with the alignment or gradient of the proposed work, and report such conflicts sufficiently in advance of the construction operations so that proper adjustments in the alignment or gradient of the proposed work may be planned to avoid such conflicts. The Owner shall not be liable for any cost or added expenses to the Contractor for delays, or for the necessary adjustment of previously installed work to avoid such conflicts, due to the Contractor's failure to advise the Owner of such conflicts adequately in advance of his construction operations.
 - 3. The Contractor shall excavate and uncover all existing utility mains to determine the exact elevations, locations, type, and size of the mains and service lines sufficiently in advance of his work, and prior to submittal of applicable shop drawings.

- E. Safety and OSHA Compliance:
 - 1. The Contractor shall comply in all respects with all Federal, State and Local safety and health regulations. Copies of the Federal regulations may be obtained from the U.S. Department of Labor, Occupation Safety and Health Administration (OSHA), Washington, DC 20210, or their regional offices.
 - 2. The Contractor shall comply in all respects with the applicable Workman's Compensation Law.

1.02 LOCATION OF PROJECT

- A. The Work is located at Collier County Northeast Water Reclamation Facility located east of the County Fairgrounds and Big Corkscrew Island Regional Park (BCIRP).

1.03 COORDINATION OF THE WORK

- A. Contractor shall have a preconstruction video made that records the project site (with the Engineer and Owner present) including all existing site features including but not limited to drainage features, concrete and asphalt pavements, curb and gutter, fencing, structures, etc.
 - 1. The original and 2 copies of the DVD shall be turned over to Engineer and Owner prior to beginning construction activities.
 - 2. The format of the video file on the DVD shall be 1 file that can be played on a desktop in the windows media player.
 - 3. The video shall clearly identify existing site and structural conditions prior to construction.
- B. Maintain overall coordination of the Work.
- C. Obtain construction schedules from each subcontractor and require each subcontractor to maintain schedules and coordinate modifications.
- D. Normal working hours shall be consistent with the typical hours required for construction. These hours shall be determined between Owner and contractor after bid award but before the start of construction. The Contractor shall pay for additional expenses, inspections and charges that may include employee charges on account of overtime or additional work that may be authorized. Such additional expenses and charges shall be a subsidiary obligation of Contractor and no extra payment shall be made by the Owner on account of such expenses and/or charges for overtime work or work outside the normal work hours.

1.04 SILTATION AND BANK EROSION

- A. The Contractor shall take adequate precautions as directed by Owner or regulatory agencies to minimize siltation and bank erosion in the vicinity of wetlands, in discharging well point systems, or during other construction activities (including flushing of pipelines).

1.05 STORAGE OF MATERIALS

- A. Suitable storage facilities shall be furnished by the Contractor. All materials, supplies, and equipment intended for use in the work shall be suitably stored by the Contractor to prevent damage from exposure, admixture with foreign substances, vandalism, or other cause. The Owner will refuse to accept, or sample for testing, materials, supplies or equipment that have been improperly stored, as determined by the Engineer. Materials found unfit for use shall not be incorporated in the work and shall immediately be removed from the construction or storage site. Delivered materials shall be stored in a manner acceptable to the Owner/Engineer before any payment for same will be made. Materials may be strung out along the line of construction as approved by Owner/Engineer.
- B. When storing materials on private property, the Contractor shall submit in writing the property owner's authorization to do so and provide all permits that may be required.

1.06 CLEAN UP

- A. The Contractor shall keep the construction site free of rubbish and other materials and restore to their original conditions those portions of the site not designated for the alternation by the Contract Documents. Clean up and restoration shall be accomplished daily throughout the contract period and in such a manner as to maintain a minimum of nuisance and interference to the general public and residents in the vicinity of the work. The Contractor shall also remove, when no longer needed, all temporary structures and equipment used in his operation. It is the intent of this Specification that the construction areas and those other areas not designated for alteration by the Contract Documents shall be immediately restored to original condition. All cleanup is subject to approval by the Owner/Engineer.
- B. Any holes or depressions, caused by the Contractor's work, shall be filled with sand or other suitable fill material, and all surfaces shall be left smooth. Any damage to buildings, shrubs, trees, plantings, or paving shall be repaired, and any damaged areas of lawn shall be re-sodded. The Contractor shall answer to any complaints of occupants or adjacent property owners.

1.07 PUBLIC SAFETY AND CONVENIENCE

- A. The Contractor shall at all times so conduct his work as to ensure the least possible obstruction to traffic, or inconvenience to the general public and residents in the vicinity of the work. No road or street shall be closed to the public, except with the permission of the Owner, Police, and Fire Department. Fire hydrants on or adjacent to the work shall be kept accessible. Provisions shall be made by the Contractor to ensure public access to sidewalks, public telephones, and the proper functioning of all gutters, sewer inlets, drainage ditches, and irrigation ditches. No open excavation shall be left overnight.

1.08 CONTRACTOR'S USE OF PREMISES

- A. Coordinate use of premises under direction of the Owner.
- B. Assume full responsibility for the protection and safekeeping of equipment and materials stored on the site.
- C. Move any stored products under Contractor's control which interfere with operations of the Owner or other Contractors.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_11_02
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 01_60_00 - Product Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_14_00
WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

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

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 METHOD OF PROCEDURE (MOP)

- A. Comply with MOP Instructions as specified in Attachment A - Method of Procedure (MOP).
- B. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.
- C. Submit Baseline Schedule, as specified in Section 01_32_21 - Schedules and Reports with proposed MOPs.
- D. Submit MOP Log at construction progress meetings.
- E. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper operation of the facility and compliance with effluent discharge criteria.
- F. Where required provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.04 GENERAL CONSTRAINTS ON WORK

- A. Perform all work in accordance with all permit requirements.

1.05 UTILITIES

- A. Provide advance notice to and utilize services of locating service(s) for location and marking of underground utilities operated by utility agencies other than the County.
 - 1. Sunshine State One Call, at 1-800-432-4770.
- B. Other locating service retained and paid by Contractor as required for the performance of the work.
 - 1. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.
 - 2. New yard utilities were designed using existing facility drawings.
 - a. Field verification of utilities locations performed during design are as noted on the drawings.
 - b. Services crossed or located nearby by new yard utilities may require relocation and possible shutdowns.
- C. Pipe alignments as indicated on the Drawings.

1.06 WORK BY OTHERS

- A. Where proper execution of the Work depends upon work by others, inspect and promptly report discrepancies and defects.

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 submit 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 complete 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/Dwg. Reference: _____

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	☐	

Work Restrictions

01_14_00-7

7126110

November 2025

pw://Carollo/Documents/Client/FL/Collier County/7126110/Specifications/01_14_00 (Bid Set)

☐	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

Work Restrictions

01_14_00-9

7126110

November 2025

pw://Carollo/Documents/Client/FL/Collier County/7126110/Specifications/01_14_00 (Bid Set)

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

Work Restrictions

01_14_00-13

7126110

November 2025

pw://Carollo/Documents/Client/FL/Collier County/7126110/Specifications/01_14_00 (Bid Set)

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 01_20_20
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Procedures for measurement and payment of Work for the conveyance system construction and above ground appurtenances of Deep Injection Wells 1 and 2, and the Dual-Zone Monitoring Well under this Contract for lump sum items.

1.02 REFERENCES

- A. Occupational Safety and Health Administration (OSHA).

1.03 PAYMENT

- A. Subject to all other contract requirements, the Contractor shall be paid for “as-built” quantities of work as percentage complete for items.
- B. No separate payment will be made for one Payment Item as Work incidentally required to complete work of another.

1.04 PAYMENT ITEMS

- A. All prices shall include costs for furnishing to the County all materials, equipment, and supplies for all costs incurred in completing the work including installation of all materials, equipment and supplies furnished, complete in place and ready for continued service, all other labor, permit fees, taxes, insurance, miscellaneous costs, overhead and profit.

1.05 LUMP SUM ITEMS

- A. Item 1: Mobilization:
 - 1. Measurement:
 - a. Mobilization of equipment and materials to the site, establishment of electric and water utilities, establishment of fluid control systems, procurement of bonds, insurance, permits, and other indirect cost items associated with the project, including items noted in Section 01_29_73.
 - b. Shall include all Contractors permits, taxes, materials, labor, equipment, and other necessary incidentals.
 - 2. Payment:
 - a. Lump sum.
 - b. Furnish data and documentation to substantiate the amounts claimed under mobilization costs.
 - c. Payment for mobilization shall not be made until mobilization items have been completed.

- B. Item 2: Demobilization:
 - 1. Measurement:
 - a. Removal of all equipment and materials not associated with the completed conveyance and injection well system, cleanup, and restoration of site.
 - b. Shall include all Contractors permits, taxes, materials, labor, equipment, and other necessary incidentals.
 - 2. Payment:
 - a. Lump sum.
- C. Item 3: Injection Well Annulus System:
 - 1. Measurement:
 - a. Includes all features of the annulus pressurized fluid system. Piping, valves, fluid storage tank, nitrogen storage cylinders, and associated elements are to be part of the system.
 - b. Shall include all Contractors permits, taxes, materials, labor, equipment, and other necessary incidentals for each item included.
 - 2. Payment:
 - a. Lump sum.
- D. Item 4: Injection Well 1 Improvements and Appurtenances:
 - 1. Measurement:
 - a. Completion of all above ground wellhead construction, installation of all piping, valves, concrete, form work, and meters, and completion of all tests as required in the specifications.
 - 2. Payment:
 - a. Lump sum.
- E. Item 5: Injection Well 2 Improvements and Appurtenances:
 - 1. Measurement:
 - a. Completion of all above ground wellhead construction, installation of all piping, valves, concrete, formwork, and meters, and completion of all tests as required in the specifications.
 - 2. Payment:
 - a. Lump sum.
- F. Item 6: Dual Zone Monitoring Well Improvements and Appurtenances:
 - 1. Measurement:
 - a. Completion of all above ground wellhead construction including equipment pad and shade structure, installation of all piping and valves, sump pumps, completion of all tests as required in the specifications.
 - 2. Payment:
 - a. Lump sum.
- G. Item 7: DIIQ Conveyance System
 - 1. Measurement:
 - a. Completion of all DIIQ conveyance system piping, valves, meters, connections, and completion of all tests as required in specifications.
 - 2. Payment:
 - a. Lump sum.

- H. Item 8: System Commissioning
 - 1. Measurement:
 - a. System commissioning shall be accomplished in accordance with contract documents.
 - 2. Payment:
 - a. Lump sum.
- I. Item 9: Project Closeout
 - 1. Measurement
 - a. Project Closeout shall be accomplished in accordance with Section 01_77_00.
 - 2. Payment:
 - a. Lump sum.

PART 2 RODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_29_73
SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Requirements for preparation, format, and submittal of Schedule of Values.
- B. Related section:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
 - 3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
 - a. Section 01_32_21 - Schedules and Reports.

1.02 PREPARATION

- A. Prepare Schedule of Values identifying costs of Major Items of Work and other costs shown in sample included at end of this Section.
- B. 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 activities equal the Contract value.
- C. 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 activities continuously equal the current Contract value.
- D. Divide the work into following major items of work:
 - 1. Mobilization.
 - 2. Demobilization.
 - 3. Injection Well Annulus System
 - 4. Injection Well 1 Improvements and Appurtenances
 - 5. Injection Well 2 Improvements and Appurtenances
 - 6. Dual Zone Monitoring Well Improvements and Appurtenances
 - 7. DIIQ Conveyance System
 - 8. System Commissioning
 - 9. Project Closeout

- E. Assign prices to Major Items of Work which aggregate the Contract Price. Base prices on costs associated with scheduled activities based on the Project Schedule for each Major Item of Work.
- F. Payment for mobilization shall be as follows:
 - 1. Based upon the Contract lump sum price for mobilization, partial payments will be allowed as follows:
 - a. With first pay request, 50%.
 - b. When 50% or more of the Contract fee is earned, 40%.
 - c. After Final Inspection, staging area clean-up, and delivery of all Project Closeout materials as required by Section 90, paragraph 90-11, *Contractor Final Project Documentation*, the remaining 10%.
 - 2. Mobilization includes, but is not limited to, the following items:
 - a. Providing final Certificates of Insurance and Payment and Performance bonds.
 - b. Applying for and submitting all required information necessary for permits.
 - c. Completing pre-construction videos and photographs.
 - d. Arranging for and erection of Contractor's staging area.
 - e. Providing on-site sanitary facilities and potable water facilities.
 - f. Moving equipment and materials necessary for the first month of operations onto the work site.
 - g. Having OSHA required notices and establishing safety programs.
 - h. Having the Contractor's Superintendent at the site full time.
 - i. Submitting initial submittals in accordance with Milestone I requirements.
- G. Project coordination with the Owner, Engineer, and permitting agencies.

1.03 SUBMITTALS

- A. Submit preliminary schedule of values within twenty (20) days of issuance of Purchase Order by Collier County.
- B. Submit corrected schedule of values within 10 days upon receipt of reviewed Schedule of Values, but no later than 10 days prior to anticipated submittal of first Application for Payment.
- C. Schedule of values shall be consistent with the bid summary sheet.
- D. Upon request, support prices with data which will substantiate their correctness.
- E. If activities are added or removed from the Progress Schedule revise the Schedule of Values and resubmit.
- F. Submit List of Subcontractors and Material Suppliers on the project.
- G. Submit completed Collier County Checklist and all Checklist attachments.
- H. Submit progress photos in one (1) hardcopy and two (2) electronic copies on CD.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_29_77
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. For stored products with item number and identification on application, description of specific material, and proof of insurance coverage for offsite stored products.
 - 8. Submit "certified" payroll, if applicable.

1.04 SUBMITTALS

- A. Submit 5 copies of 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 01_31_19
PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
 - 1. Pre-construction Conference.
 - 2. Progress Meetings.
 - 3. Pre-Installation Meetings.
 - 4. Schedule Update Meetings.
 - 5. Quality Control Meetings.
 - 6. Close-out meeting.

1.02 BASIC MEETING REQUIREMENTS

- A. Attendees:
 - 1. Meeting leader shall require attendance of parties directly affecting, or affected by, Work being discussed at the meeting.
- B. Notification:
 - 1. Meeting leader shall notify attendees of meeting a minimum of 5 days prior to meeting.
- C. Agenda:
 - 1. Meeting leader shall submit meeting agenda to attendees a minimum of 2 days prior to meeting.
 - 2. Meeting leader shall prepare copies of agenda for participants and distribute at the meeting.
- D. Meeting minutes:
 - 1. Meeting leader shall provide draft minutes within 7 days of meeting and send to all attendees for comment within 7 days.
 - 2. Meeting leader shall incorporate comments from attendees and submit final meeting minutes to attendees within 7 days of receipt of comments.

1.03 PRE-CONSTRUCTION CONFERENCE

- A. Engineer leads the meeting.
- B. Timing:
 - 1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable.

- C. Location:
 - 1. In location convenient for most invitees.
- D. Attendees:
 - 1. Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors, and others involved in performance of the Work, and others necessary to agenda.
- E. Purpose of conference:
 - 1. To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, cost breakdown of major lump sum items, processing of submittals and applications for payment, and other subjects pertinent to execution of the Work.
- F. Agenda minimum requirements:
 - 1. Adequacy of distribution of Contract Documents.
 - 2. Distribution and discussion of list of major subcontractors and suppliers.
 - 3. Proposed progress schedules and critical construction sequencing.
 - 4. Major equipment deliveries and priorities.
 - 5. Project coordination.
 - 6. Designation of responsible personnel.
 - 7. Procedures and processing of:
 - a. Field decisions.
 - b. Proposal requests.
 - c. Submittals.
 - d. Change Orders.
 - e. Request for Information/Interpretations.
 - f. Applications for Payment.
 - g. Record Documents.
 - 8. Use of premises:
 - a. Office, construction, and storage areas.
 - b. Owner's requirements.
 - 9. Construction facilities, controls, and construction aids.
 - 10. Temporary utilities.
 - 11. Safety and first aid procedures.
 - 12. Security procedures.
 - 13. Housekeeping procedures.

1.04 PROGRESS MEETINGS

- A. Engineer will lead the meeting.
- B. Timing:
 - 1. Hold meetings throughout progress of the Work at maximum weekly intervals.
- C. Attendance required:
 - 1. Owner, Engineer, Contractor, Contractor's Project Manager, superintendent, quality control manager, project scheduler, and major subcontractors and suppliers as appropriate to agenda topics for each meeting.

- D. Additional invitees:
 - 1. Others when the Work affects their interests.
- E. Agenda minimum requirements:
 - 1. Review minutes of previous meeting/minutes.
 - 2. Safety and security.
 - 3. Construction schedule summary.
 - 4. Review of 6 weeks schedule.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Request for information (RFI's) status.
 - 7. Change order management status.
 - 8. Field observations, problems, and conflicts.
 - 9. General Items.
 - 10. Action items.
 - 11. Next meeting.

1.05 PRE-INSTALLATION MEETINGS

- A. Contractor leads the meeting.
- B. Timing:
 - 1. When specified in Technical Sections or requested by Engineer, convene pre-installation meeting at Project site before commencing Work of specific section.
- C. Agenda:
 - 1. Review conditions of installation, preparation and installation procedures.
 - 2. Review coordination with related work.

1.06 SCHEDULE UPDATE MEETINGS

- A. Contractor leads the meeting.
- B. Timing:
 - 1. Hold meetings throughout progress of the Work at maximum monthly intervals.
- C. Attendees:
 - 1. Owner, Engineer, Contractor, Contractor's Project Manager, General Superintendent, project scheduler, major subcontractors and suppliers as appropriate to agenda topics for each meeting.
 - 2. Additional invitees:
 - a. Others when the Work affects their interests.
- D. Agenda minimum requirements:
 - 1. Review Monthly Schedule, (Actual Progress and Variance).
 - a. "Activities Started/Completed" this period.
 - b. "Activities Started/Completed" "Variance" Baseline vs. current.
 - c. "Added/Deleted Activities".
 - d. "Revised Activity Descriptions".
 - e. Any significant Proposed Logic Changes.

2. Review milestone "Substantial Completion" Schedule:
 - a. "Critical" Activities - "Critical Area, Float and Vital Statistics".
3. Review "Cumulative and Monthly Costs" graph.
4. Review "Budgeted Cost" indicating the Current Project Budgeted Cost.

1.07 QUALITY CONTROL MEETINGS

- A. Contractor leads the meeting.
- B. Timing:
 1. Hold meetings throughout progress of the Work at maximum weekly intervals.
- C. Attendees:
 1. Engineer, Construction Manager and staff, Contractor's Quality Control Manager, and staff.
- D. Agenda minimum requirements:
 1. Review minutes of previous meetings.
 2. Review of Work progress and schedule.
 3. Review of out-of-compliance inspection or test results.
 4. Field observations, problems, and decisions.
 5. Review of offsite fabrication and delivery schedules.
 6. Planned progress during succeeding work period.
 7. Coordination of required inspections and tests.
 8. Review 6-week schedule report with upcoming inspections and special tests.
 9. Maintenance of quality and work standards.
 10. Other business relating to Work.

1.08 CLOSE-OUT MEETING

- A. Engineer leads the meeting.
- B. Attendees:
 1. Owner, Engineer, Contractor, Contractor's Project Manager, and Superintendent.
- C. Agenda minimum requirements:
 1. Review punch list completion.
 2. Transfer of record documents.
 3. Finalize payment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_31_24

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for web-based construction document management.

1.02 REQUIREMENTS

- A. Owner, Engineer, and Contractor shall utilize EADOC (EADOC is a registered trademark of EADOC LLC). For submission of all data and documents (unless specified otherwise in this Section) throughout the duration of the Contract.
 - 1. EADOC is a web-based electronic media site hosted by EADOC LLC.
 - 2. EADOC is available to all Contractor's personnel, subcontractor personnel, suppliers, consultants, Owner, and Engineer at no cost.
 - 3. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
 - 4. EADOC shall be the primary means of project information submission and management.

1.03 USER ACCESS LIMITATIONS

- A. Provide a list of Contractor's key EADOC personnel for the Owner/Engineer's acceptance. The Owner/Engineer reserves the right to perform a security check on all potential users. The Contractor will be allowed to add additional personnel and subcontractors to EADOC.
- B. The Owner/Engineer will grant initial access to EADOC by creating user profiles to accepted Contractor personnel. User profiles will define levels of access into the system; determine assigned function-based authorizations and user privileges. Subcontractors and suppliers will be given access to EADOC by and through the Contractor. Contractor is responsible for adding and removing users from the system after the initial setup by the Owner/Engineer.

1.04 JOINT OWNERSHIP OF DATA

- A. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the EADOC system) by Owner/Engineer and Contractor will be jointly owned.

1.05 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

- A. Review comments made (or lack thereof) by Owner on Contractor submitted documentation shall not relieve Contractor from compliance with requirements of the Contract Documents. Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

1.06 COMPUTER REQUIREMENTS

- A. Contractor shall use computer hardware and software that meets the requirements of the EADOC system as recommended by EADOC LLC to access and utilize EADOC. As recommendations are modified by EADOC, Contractor will upgrade their system(s) to meet or exceed the recommendations. Upgrading of Contractor's computer systems will not be justification for a cost or time modification to the Contract.
- B. Contractor shall ensure that connectivity to the EADOC system is accomplished through DSL, cable, T-1, or wireless communications systems. The minimum bandwidth requirements for using the system is 128 kb/s. It is recommended a faster connection be used when uploading pictures and files into the system.
- C. EADOC supports the current and prior 2 major versions of Chrome, Mozilla's Firefox, Microsoft's Internet Explorer, and Apple's Safari on a rolling basis.
 - 1. Each time a new version of one of these browsers is released, EADOC will begin supporting the update and stop supporting the fourth-oldest version.

1.07 CONTRACTOR RESPONSIBILITY

- A. Contractor shall be responsible for the validity of their information placed in EADOC and for the abilities of their personnel.
- B. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on EADOC shall be the responsibility of the Contractor.
- C. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, cad drawing applications, and Adobe Portable Document Format (PDF) document distribution program.
- D. Contractor shall utilize the existing forms in EADOC to the maximum extent possible. If a form does not exist in EADOC the Contractor must include a form of their own or provided by Engineer as an attachment to a submittal.
- E. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. Contractor is responsible for the training of their personnel in the use of EADOC (outside what is provided by Owner), and the other programs indicated above as needed.

1.08 TRAINING

- A. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate Contractor's training.

PART 2 PRODUCTS

2.01 DESCRIPTION

- A. EADOC project management application (no equal). Provided by EADOC LLC, www.EADOCsoftware.com.

PART 3 EXECUTION

3.01 EADOC UTILIZATION

- A. EADOC shall be utilized in connection with all document and information management required by these Contract Documents.

3.02 SUBMITTALS

- A. Use EADOC for submittals.
- B. Content: As specified in Section 01_33_00 - Submittal Procedures.
- C. Format: As specified in Section 01_33_00 - Submittal Procedures.
- D. Submit Portable Document Format (PDF) documents to the EADOC submittal work flow process and forms.
 - 1. Consolidate electronic format submittals with multiples pages into a single file.
- E. Samples:
 - 1. Contractor shall enter submittal data information into EADOC.
 - 2. Attach a copy of the submittal form(s) to the sample.
- F. Record And Closeout Submittals:
 - 1. Operation and maintenance data as specified in Section 01_78_24 - Operation and Maintenance Manuals.
 - 2. Extra materials, spare parts, etc.

3.03 OFFICIAL CORRESPONDENCE

- A. Use EADOC for memos, notices, change proposals, or any official correspondence.

3.04 INSPECTION REQUESTS

- A. Use EADOC to request inspection for a portion of Work that is ready for inspection and prior to covering up the Work.

3.05 FINANCIAL SUBMITTALS

- A. Use EADOC for financial submittals as specified in Section 01_33_00 - Submittal Procedures.

3.06 OTHER

- A. Use EADOC for daily reports, meeting agendas and minutes, and other construction documents.

END OF SECTION

SECTION 01_32_21
SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Schedules and reports.

1.02 SUBMITTAL REQUIREMENTS

- A. Submit preliminary and baseline schedule.
- B. Submit preliminary and baseline schedule of values.
- C. Submit preliminary and baseline schedule of submittals.
- D. Submit, on a monthly basis, updated schedules as specified.
- E. Submit final schedule update as specified.
- F. Submit revised schedules and time impact analyses as specified.
- G. Submit schedules in the media and number of copies as follows:
1. Provide each submittal in PDF format and in other formats specified in this Section.
 2. 3 sets of the CPM network and/or bar chart (as specified by the Owner) on D-size sheets.
 - a. Color-coding to be specified by the Owner.
 3. 3 sets of tabular reports listing all activities sorted numerically identifying duration, early start, late start, early finish, late finish, total float, and all predecessor/successor information.
 4. 2 sets of CPM Schedule data electronic files in a native backed-up file (.xer).

1.03 SCHEDULER

- A. Designate, in writing and within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.
- B. Qualifications of scheduler:
1. Authority to act on behalf of Contractor.
 2. A minimum of 5 years verifiable experience in preparation of construction schedules for projects of similar value, size, and complexity.
 3. Knowledge of critical path method (CPM) scheduling utilizing Primavera P6 Professional software.
- C. Owner reserves the right to disapprove scheduler when submitted by Contractor if not qualified.

- D. Owner reserves the right to remove scheduler from the project if found to be unqualified.

1.04 SCHEDULING FORMAT AND SOFTWARE

- A. Schedule format: Utilize CPM format.
- B. Prepare computerized schedule utilizing Primavera P6 Professional, most current version.
 - 1. Provide 1 licensed copy of the scheduling software to the engineer, registered in the Engineer's name, for the duration of the project.
 - 2. The provided copy of the software shall be a standalone version for installation on a standalone computer.
- C. Contractor and Engineer must agree on the format.

1.05 PRECONSTRUCTION SCHEDULING MEETING

- A. Engineer will conduct Preconstruction Scheduling Meeting with Contractor's Project Manager, General Superintendent, and scheduler within 7 calendar days after Notice to Proceed.
 - 1. This meeting is separate from the Preconstruction Conference Meeting and is intended to exclusively cover schedule issues.
- B. At the meeting, review scheduling requirements:
 - 1. These include schedule preparation, reporting requirements, updates, revisions, and schedule delay analysis
 - 2. Present schedule methodology, planned sequence of operations, cost and resource loading methodology, and proposed activity coding structure.
 - 3. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule.
 - a. Example 1: 2014_07_30 rev 1 draft baseline schedule.xer.
 - b. Example 2: 2014_09_30 rev 2 sep final update.xer.
- C. Filing: Post submitted files to Owner's construction document control system.

1.06 REVIEW AND ACCEPTANCE OF SCHEDULES

- A. Engineer will review Baseline Schedule, Schedule Updates, Schedule Revisions and Time Impact Analyses to ascertain compliance with specified project constraints, compliance with milestone dates, reasonableness of durations and sequence, accurate inter-relationships, and completeness.
- B. Engineer and Owner will issue written comments following completion of review of Baseline Schedule 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 schedule in accordance with Engineer's comments within 7 calendar days after receipt of such comments or request joint meeting to resolve objections.
- E. If Engineer requests a meeting, the Contractor and all major subcontractors must participate in the meeting with Engineer.
 - 1. Revise and resubmit schedule within 7 calendar days after meeting.
- F. Use accepted schedule for planning, organizing, and directing the work and for reporting progress.
- G. Engineer's submittal review response:
 - 1. When schedule reflects Owner's and Contractor's agreement of project approach and sequence, schedule will be accepted by Owner.
 - 2. Engineer's submittal review response for schedule submittal will be "Receipt Acknowledged - Filed for Record" including applicable comments.
 - 3. Acceptance of the schedules by the Owner is for general conformance with the Contract Documents and for 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. Omissions and errors in the accepted schedules shall not excuse performance less than that required by the Contract Documents. 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.

1.07 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 in this Section under Revisions to Schedule.
- 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.
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 01_29_77 - Applications for Payment, submittal and acceptance of the monthly Schedule Update is a condition precedent to the making of any progress payments.

1.08 REVISIONS TO SCHEDULE

- A. Submit Revised Schedule 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).

1.09 SCHEDULE PREPARATION

- A. Preparation and submittal of Progress Schedule represents Contractor's intention to execute the Work within specified time and constraints.
- B. Contractor's bid covers all costs associated with the execution of the Work in accordance with the Progress Schedule.
- C. During preparation of the preliminary Progress Schedule, Engineer will facilitate Contractor's efforts by being available to answer 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 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 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 with beginning of 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, hidden logic prohibited: Do not use imposed dates or hidden logic in preparation of schedule.
- 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. Commissioning schedule:
1. Commissioning activities and milestones shall be an integral part of the overall project schedule.
 2. Commissioning activities and milestones shall be extracted from the main project schedule to provide a separate commissioning schedule that is submitted each time the project schedule is submitted.
- L. Cost loading:
1. Only on-site construction activities.
 2. The sum total of all activities equal to the current value of the Contract, including change orders, at all times.
 3. Owner acceptance of the Baseline Schedule creates the Schedule of Values required as specified in Section 01_29_73 - Schedule of Values.
 4. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01_29_77 - Applications for Payment.
 5. Payments will not be made until updated Schedule of Values is accepted.

1.10 NETWORK DETAILS AND GRAPHICAL OUTPUT

- 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. Indicate the critical path for the project.
- E. Delineate the specified contract duration 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 unless a Change Order is issued to officially change the Contract completion date.
- F. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion date as milestones.
- G. Include, in addition to construction activities:
 - 1. Submission dates and review periods for major equipment submittals, shoring submittals, and indicator pile program:
 - a. Shoring reviews: Allow 4-week review period for each shoring submittal.
 - b. Pile indicator program: Allow 3-week review period for analysis of program.
 - 2. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
 - 3. Equipment and long-lead material deliveries over 8 weeks.
 - 4. Approvals required by regulatory agencies or other third parties.
- H. Produce network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

1.11 WEATHER DAY ALLOWANCE

- A. Definition:
 - 1. Weather conditions that prevent or inhibit the Contractor's performance of the Work and affect the Critical Path indicated on the Schedule shall be referred to as a Weather Day.
 - 2. A Weather Day is defined as the Contractor being unable to perform at least 4 hours of work on the Critical Path.

- B. Allowance: 15 days.
 - 1. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Days Allowance".
- C. Actual weather day:
 - 1. Insert a weather delay activity in critical path to reflect actual weather day occurrences when weather days are experienced and accepted by Engineer.
 - 2. Reduce duration of Weather Days Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in Weather Day Allowance at completion of project is considered float.
 - 3. The Contractor shall provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and shall 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. The 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.
 - d. Weather days are considered excusable delay as defined in this Section.

1.12 BASELINE SCHEDULE AND BASELINE SCHEDULE OF VALUES

- A. Due date: No more than 45 calendar days after Notice to Proceed.
- B. Format:
 - 1. 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 01_29_73 - Schedule of Values.

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 01_29_77 - 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 01_29_77
- Applications for Payment.
- B. Format: Schedule of Values: As specified in Section 01_29_73 - Schedule of Values.

1.16 COMMISSIONING SCHEDULE

- A. Proposed Commissioning Schedule:
 - 1. Engineer response due within 20 calendar days of receipt.
 - 2. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.
- B. 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.
- C. 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.

1.17 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.

Not Used.

Not Used.

Schedules and Reports

SECTION 01_33_00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: 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 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
 - a. The only exception to this requirement is when 1 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 page size will be 8 1/2 inches by 11 inches:
 - 2. Maximum page size will be 11 inches by 17 inches.

- H. Drawing sheet size:
 - 1. Maximum sheets size: 22-inch by 34-inch.
 - a. Minimum plan scale: 1/8-inch equals 1 foot-0 inches.
 - b. Minimum font size: 1/8 inch minimum.
 - 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 minimum.
- I. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
- J. Provide submittal information from only 1 manufacturer for a specified product. Submittals with multiple manufacturers for 1 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. Specification section: 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. Drawings: 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 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 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 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 METHOD AND FORMAT

A. Submittal identification numbering:

1. Number each submittal using the format defined below:

	Spec Section Number	Dash	Initial Submittal - Sequential Number	Decimal Point	Subsequent Submittal Revisions Sequential Number
<i>Example 1 Description</i>	<i>Cast-In-Place Concrete</i>		<i>8th initial submittal</i>		
	00_30_30	-	0008		
<i>Example 2 Description</i>	<i>Cast-In-Place Concrete</i>		<i>8th initial submittal</i>		<i>First revision to the 8th initial submittal</i>
	00_30_30	-	0008	.	1

B. Submittals in electronic media format:

1. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.
2. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).
3. Graphics: Provide graphic submittals (drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

1.05 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 Contractor from Contractor's responsibility for performance of requirements of Contract Documents. Neither shall Engineer's review release Contractor from fulfilling purpose of installation nor from 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 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 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 Engineer's failure to return submittal within time indicated and accepted by Engineer.
- 4. Review response will be returned to 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) The 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) The 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) The 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 - Filed for record:
 - 1) 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.
 - d. Receipt acknowledged with comments - Resubmit:
 - 1) 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.
 - 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 throughout the submittal and numbered consistent with the Engineer's numbering.
 - a. Acceptable responses to 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 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. 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 Engineer in writing.
- 4. Review costs:
 - a. Costs incurred by Owner as a result of additional reviews of a particular submittal after the second time it has been reviewed shall be borne by Contractor.
 - b. Reimbursement to Owner will be made by deducting such costs from Contractor's subsequent progress payments.

1.06 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.

1.07 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.

1.08 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.:	XXXXXX.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:			
In the event, Contractor believes the Submittal response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.			
Firm:	Click here to enter text.	Signature:	Date Returned: XX/XX/XXXX

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 01_41_00
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. Local Requirements: Contractor shall be responsible for complying with the Collier County Water-Sewer District Utilities Standards Manual (CCWSDUS) applicable specifications, details, and guidelines, and the Florida Department of Environmental Protection (FDEP) requirements. In case of discrepancy among the Contract Documents and the CCWSDUS documents, the most restrictive requirements shall govern. In the event that any conflicts cannot be resolved by reference to this provision, then Owner shall resolve the conflict in any manner which is acceptable to Owner, and which comports with the overall intent of the Contract Documents.

1.03 APPLICABLE CODES

- A. Florida Building Commission (FBC):
1. Building code:
 - a. Florida Building Code, 7th Edition, 2020: Building.
 2. Fire code:
 - a. Florida Fire Prevention Code, 6th Edition, 2017.
 3. Mechanical code:
 - a. Florida Building Code, 7th Edition, 2020: Mechanical.
 4. Plumbing code:
 - a. Florida Building Code, 7th Edition, 2020.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_45_00

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. Owner will employ and pay for specified services of an "Owner's independent testing firm" certified to perform testing and inspection as required in the technical specifications for various work and materials or stipulated in Section 01_45_24 - Regulatory Quality Assurance to confirm Contractor's compliance with Contract Documents.
- C. The Owner's independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.
- D. 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.
- E. 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.
- F. Contractor shall cooperate with Owner's independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 - 1. Notify Engineer and Owner's independent testing firm 48 hours prior to expected time for operations requiring testing.
 - 2. Make arrangements with Owner's independent testing firm and pay for additional samples and tests required for Contractor's use.
- G. Limitations of authority of testing Laboratory: Owner's independent testing firm or Laboratory is not authorized to:
 - 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency or laboratory may not approve or accept any portion of the Work.
 - 3. Agency or laboratory may not assume duties of Contractor.
 - 4. Agency or laboratory has no authority to stop the Work.

- H. Testing and employment of an Owner's independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.
- J. The Owner's independent testing firm responsibilities will include:
 - 1. Test samples of mixes submitted by Contractor.
 - 2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products in accordance with specified standards.
 - 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
 - 6. Perform additional tests required by Engineer.
 - 7. Attend preconstruction meetings and progress meetings when requested.
- K. Owner's independent testing firm individual test reports:
 - 1. After each test, Owner's independent testing firm will promptly submit electronically report to Engineer and to Contractor.
 - 2. Test reports shall include at least the following information:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in Project.
 - g. Type of inspection or test.
 - h. Date of test.
 - i. Certified test results stamped and signed by a registered Engineer in the state where the project is located.
 - j. Summary of conformance with Contract Documents.
 - k. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results.

1.10 CONTRACTOR'S RESPONSIBILITIES

- A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.
- B. 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.

- C. 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.
- D. Submit product test reports electronically.
- E. 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.
- F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01_45_24
REGULATORY QUALITY ASSURANCE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: This Section describes project regulatory requirements for quality assurance that includes special inspections, special certification, and structural observation.

1.02 REFERENCES

- A. American Concrete Institute (ACI):
1. 318 - Building Code Requirements for Structural Concrete.
 2. 530 – Building Code Requirements for Masonry Structures.
 3. 530.1 – Specification for Masonry Structures.
- B. American Institute of Steel Construction (AISC):
1. 360 – Specification for Structural Steel Buildings.
- C. American Society of Civil Engineers (ASCE):
1. 7 - Minimum Design Loads for Buildings and Other Structures.
- D. American Welding Society (AWS):
1. D1.3 - Structural Welding Code - Sheet Steel.
 2. D1.4 - Structural Welding Code - Reinforcing Steel.
- E. ASTM International (ASTM):
1. A706 – Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
 2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 3. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 4. C1611 Standard Test Method for Slump Flow of Self-Consolidating Concrete.

1.03 DEFINITIONS

- A. Special Inspection: Inspection of the materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.
- B. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

- C. Special Inspection, Periodic: The part-time, or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed and at the completion of the work.

1.04 DESCRIPTION

- A. This Section describes special inspections, special certification and structural observation of structural assemblies and components to be performed in compliance with the building code specified in Section 01_41_00 - Regulatory Requirements.
- B. The special certification and special inspections specified in this Section are in addition to the requirements specified in Section 01_45_00 - Quality Control, and by the individual Sections.

1.05 SUBMITTALS

- A. Contractor shall schedule and coordinate the submittal of Special Inspection reports and test results prepared by others.

1.06 SPECIAL INSPECTION

- A. Contractor shall employ special inspectors who will provide special inspections during construction.
- B. Special inspector(s) shall be qualified for inspection of the particular type of materials or operations requiring special inspection.
- C. Testing laboratory: Contractor shall provide testing that is required to satisfy the requirements of special inspection. Testing shall be performed by the testing laboratory as specified in Section 01_45_00 - Quality Control.
- D. Duties of Special Inspector:
 - 1. General: Required duties of the special inspector(s) shall be as described in Chapter 17 of the building code specified in Section 01_41_00 - Regulatory Requirements.
 - 2. Reporting: Special inspector(s) shall provide reports of each inspection to the Owner and shall distribute copies of inspection reports to the Engineer and Contractor as required.
 - a. Reports shall, at a minimum, include the following items:
 - 1) Date and time of inspection, and name(s) of individual(s) performing the inspection.
 - 2) Structures and areas of the structure where work or testing was observed.
 - 3) Discrepancies between the requirements of the Contract Documents and the work or testing observed.
 - 4) Other areas of deficiency in the Work.
- E. Special inspections shall not be construed as fulfilling the requirements for structural observation.

- F. Owner or special inspector are responsible to select materials for special inspection.
 - 1. It is not acceptable for Contractor to select materials for special inspection.

1.07 SPECIAL CERTIFICATION

- A. Contractor shall be responsible for providing equipment that meets the special certification requirements of the building code specified in Section 01_41_00 – Regulatory Requirements.

1.08 STRUCTURAL OBSERVATION

- A. Contractor will employ 1 or more registered design professionals who will provide structural observation(s) during construction.
 - 1. Registered design professional shall be a civil or structural engineer currently licensed as such in the state where the project is located and regularly engaged in structural design equivalent to or similar to those indicated on the Drawings.
- B. Structural observations shall not be construed as fulfilling the requirements for special inspections.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SPECIAL INSPECTIONS

- A. The Contractor shall provide special inspection of following types of work as described in in Section 1705 of the building code as specified in Section 01_41_00 - Regulatory Requirements wherever such work occurs unless otherwise specified.
 - 1. Attachment A - Concrete Special Inspection Schedule.
 - 2. Attachment B - Mechanical Components - Special Inspection Schedule.
 - 3. Attachment D - Soils Verification and Inspection Schedule.
 - 4. Attachment E - Structural Steel Special Inspection Schedule.
 - 5. Attachment F - Structural Steel Bolting Special Inspection Schedule.

3.02 STRUCTURAL OBSERVATION

- A. The following work requires structural observation in accordance with Section 1704.5 of the building code specified in Section 01_41_00 - Regulatory Requirements.
 - 1. All structures in all areas:
 - a. Foundations.
 - b. Elevated slabs.

3.03 SCHEDULE

- A. Contractor shall allow time necessary for special inspections and structural observation specified herein.
- B. Sufficient notice shall be given so that the special inspections and structural observations can be performed. Contractor shall allow time for individuals performing special inspection and structural observation to travel to the site.

3.04 PROCEDURE

- A. The special inspector will immediately notify the Engineer of any corrections required and follow notification with appropriate documentation.
- B. Contractor shall not proceed until the work is satisfactory to the Engineer.

END OF SECTION

ATTACHMENT A - CONCRETE SPECIAL INSPECTION SCHEDULE

CONCRETE SPECIAL INSPECTION SCHEDULE
(Includes: cast-in-place, precast, prestressed, precast-prestressed, and shotcrete.)

Verification and Inspection	Reference Standard ACI 318-14 AWS D1.4-18 IBC 2018	Frequency of Inspection ⁽¹⁾ (During Task Listed)	
		Continuous	Periodic
1. Inspect reinforcement, including prestressing tendons, and verify placement.	ACI 318: 20, 25.2, 25.3, 26.6.1-26.6.3 IBC: 1908.4		●
2. Reinforcing bar welding:			
a. Verify weldability of reinforcing bars other than ASTM A706;	AWS D1.4 ACI 318: 26.6.4		●
b. Inspect single-pass fillet welds, maximum 5/16"; and	AWS D1.4 ACI 318: 26.6.4		●
c. Inspect all other welds.	AWS D1.4 ACI 318: 26.6.4	●	
3. Inspect anchors cast in concrete.	ACI 318: 17.8.2		●
4. Inspect anchors post-installed in hardened concrete members.			
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads.	ACI 318: 17.8.2.4	●	
b. Mechanical anchors and adhesive anchors not defined in 4.a.	ACI 318: 17.8.2		●
5. Verify use of required design mix.	ACI 318: 19, 26.4.3, 26.4.4 IBC: 1904.1, 1904.2, 1908.2, 1908.3		●
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	ASTM C172 ASTM C31 ACI 318: 26.5, 26.12 IBC: 1908.10	●	
7. Inspect concrete and shotcrete placement for proper application techniques.	ACI 318: 26.5 IBC: 1908.6, 1908.7, 1908.8	●	

Verification and Inspection	Reference Standard ACI 318-14 AWS D1.4-18 IBC 2018	Frequency of Inspection ⁽¹⁾ (During Task Listed)	
		Continuous	Periodic
8. Verify maintenance of specified curing temperature and techniques.	ACI 318: 26.5.3-26.5.5 IBC: 1908.9		●
9. Inspect prestressed concrete for:			
a. Application of prestressing forces; and	ACI 318: 26.10	●	
b. Grouting of bonded prestressing tendons.	ACI 318: 26.10	●	
10. Inspect erection of precast concrete members.	ACI 318: 26.9		●
11. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	ACI 318: 26.11.2		●
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	ACI 318: 26.11.1.2.(b)		●
Notes:			
(1) The "●" represents a required inspection activity for the project where it occurs.			

ATTACHMENT B - MECHANICAL COMPONENTS - SPECIAL INSPECTION SCHEDULE

**MECHANICAL AND ELECTRICAL COMPONENTS
SPECIAL INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection ⁽¹⁾ (During Task Listed)	
		Continuous	Periodic
1. Plumbing, mechanical, and electrical components:			
a. Installation and anchorage of pipelines greater than 8 inches in diameter.	IBC: 1705.12.6.3		●
Notes: (1) The "●" represents a required inspection activity for the project where it occurs.			

ATTACHMENT C - SOILS VERIFICATION AND INSPECTION SCHEDULE

SOILS VERIFICATION AND INSPECTION SCHEDULE

Verification and Inspection	Reference Standard IBC 2018	Frequency of Inspection ⁽¹⁾ (During Task Listed)	
		Continuous	Periodic
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	IBC: T-1705.6		●
2. Verify excavations are extended to proper depth and have reached proper material.	IBC: T-1705.6		●
3. Perform classification and testing of fill and backfill materials.	IBC: T-1705.6		●
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of fill and backfill.	IBC: T-1705.6	●	
5. Prior to placement of fill, observe subgrade and verify that site has been prepared properly.	IBC: T-1705.6		●
Notes: (1) The "●" represents a required inspection activity for the project where it occurs.			

SECTION 01_50_00

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, , 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 01_33_00 - Submittal Procedures.

1.04 TEMPORARY UTILITIES

- A. Temporary electrical power:
 - 1. Arrange with local utility to provide adequate temporary electrical service.
 - 2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
 - 3. Provide, maintain, and pay for electric power for performance of the Work.
- 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 water:
 - 1. Contractor will not need to pay for water. Contractor shall construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
 - 2. Remove temporary piping and connections and restore affected portions of the facility to original condition before final acceptance.
 - 3. Pay for water used.

- D. 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.
- E. Temporary fire protection:
 - 1. Provide fire protection required to protect the Work and ancillary facilities.
- F. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.
- G. Utilities in existing facilities: As specified in Section 01_14_00 - Work Restrictions.

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. Barricades:
 - 1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
 - 2. Provide barriers with flashing lights after dark.
 - 3. Keep barriers in place until excavations are entirely backfilled and compacted.
 - 4. Barricade excavations to prevent persons from entering excavated areas.
- F. 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.

- G. Hazards in public right-of-way:
 - 1. Comply with local jurisdiction standards and requirements for right-of-way barricades and other safety devices.
 - 2. Mark at reasonable intervals, trenches, and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
 - a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
 - 3. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
 - a. During hours of darkness, provide warning lights at close intervals.
- H. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.
- I. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.
- J. Fences:
 - 1. Enclose site of the Work with fence adequate to protect the Work against acts of theft, violence, and vandalism.
 - 2. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons.
 - a. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.
 - 3. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures, or enlist services of security guards to protect temporary openings.
 - 4. Fence temporary openings when openings are no longer necessary.

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 ACCESS ROADS

- A. General:
 - 1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
 - 2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.
- B. Off-site access roads:
 - 1. Build and maintain graded earth roads.
 - 2. Build roads only in public right-of-way or easements obtained by Owner.

3. Obtain rights-of-way or easements when electing to build along other alignment.
- C. On-site access roads:
 1. Maintain access roads to storage areas and other areas to which frequent access is required.
 2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
 3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
 4. Maintain on-site access roads free of mud.
 5. Provide controls to prevent vehicles leaving the site from tracking mud off the site onto the public right-of-way.

1.08 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.
- C. Mud control:
 1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.09 PROJECT SIGN

- A. Provide and maintain Project identification sign consisting of painted 8-foot wide by 4-foot high exterior grade plywood and minimum 10-foot long, 4 by 4 lumber posts, set in ground at least 3 feet, with exhibit lettering by professional sign painter using no more than 5 sign colors:
 1. List at least the title of the Project, and names of the Owner, Engineer, and Contractor.
 2. Identify Contractor's, Engineer's, names in upper right-hand corner underneath the bid number.
- B. Erect Project identification sign where directed by Engineer within 14 days after the issuance of the Notice to Proceed.
- C. Replace or repair the project sign if it is damaged or covered with graffiti within 2 working days of observation or notification of damage or graffiti.

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 01_56_17

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Installation of erosion and sediment control filter fabric fences.
 - 2. Triangular filter fabric fences.
 - 3. Straw bale fences and brush berms used during construction and prior to final development of site.
- B. Purpose of control fences is to contain pollutants from overland flow.
 - 1. Control fences are not for use in channelized flow areas.

1.02 UNIT PRICES

- A. Measure and pay for filter fabric fence by linear foot of completed and accepted filter fabric fence installed around construction site. Limits of construction site are indicated on the Drawings.
- B. Measure and pay for triangular filter fabric fence by linear feet of completed and accepted triangular filter fabric fence between limits of beginning and ending of wooden stakes.
- C. Measure and pay for straw bale barrier by linear feet of completed and accepted straw bale barrier.
- D. Measure and pay for brush berm by linear feet of completed and accepted brush berm.

1.03 SUBMITTALS

- A. Manufacturer's catalog sheets and other product data on geotextile fabric.

1.04 REFERENCES

- A. ASTM International (ASTM):
 - 1. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - 2. D4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.
 - 3. D4491- Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - 4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

5. D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes, and Related Products.
6. D5665- Standard Specification for Thermoplastic Fabrics Used in Cold-Applied Roofing and Waterproofing.
7. D6459 - Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
8. D6475 - Standard Test Method for Measuring Mass per Unit Area of Erosion Control Blankets.
9. D6525 - Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products.
10. D6567 - Standard Test Method for Measuring the Light Penetration of a Rolled Erosion Control Product (RECP).
11. D6818 - Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products.

1.05 QUALITY ASSURANCE FOR EROSION CONTROL BLANKETS

- A. Product shall be manufactured in accordance with a documented Quality Control Program. At a minimum, the following procedures and documentation shall be provided:
 1. Manufacturing Quality Control Program Manual.
 2. First piece inspection of products produced to assure component materials and finished product tolerances are within manufacturer specifications.
 3. Additional inspections for product conformance shall be conducted during the run after the first piece inspection.
 4. Every roll shall be visually inspected.
 5. Moisture content of straw and coconut fibers measured upon receipt.
 6. At a minimum, every third roll shall be weighed to insure conformance of manufacturer's specifications.
 7. Each individual erosion control blanket shall be inspected prior to packaging for conformance to manufacturing specifications.

1.06 PERFORMANCE REQUIREMENTS FOR EROSION CONTROL BLANKETS

- A. Erosion control blanket shall provide a temporary, biodegradable cover material to reduce slope and enhance vegetation. Erosion control blanket performance capabilities shall be in accordance with ASTM D6459, "Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall-Induced Erosion."

PART 2 PRODUCTS

2.01 FILTER FABRIC

- A. Provide woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material.

- B. Geotextile fabric:
 - 1. Grab strength of 100 pounds per square inch in any principal direction in accordance with ASTM D4632.
 - 2. Puncture strength exceeding 115 pounds per square inch in accordance with ASTM D4833.
 - 3. Equivalent opening size between 50 and 140 for soils with more than 15 percent by weight passing No. 200 sieve and between 20 and 50 for soil with less than 15 percent by weight passing No. 200 sieve.
 - 4. Maximum water flow rate of 40 gallons per minute per square feet in accordance with ASTM D4491.
- C. Filter fabric material shall contain ultraviolet inhibitors and stabilizers to provide expected usable life comparable to anticipated construction period.
 - 1. Ultraviolet stability shall exceed 70 percent after 500 hours of exposure in accordance with ASTM D4355.
- D. Manufacturers: The following or equal:
 - 1. Mirafi, Inc.

2.02 EROSION CONTROL BLANKETS

- A. Manufacturers: One of the following or equal:
 - 1. American Excelsior Co., AEC Premier Straw/Coconut™ Blankets.
 - 2. Proper Geotextile Systems.
- B. Product requirements:
 - 1. Erosion control blanket shall be furnished in rolls and wrapped with suitable material to protect against moisture intrusion and extended ultraviolet exposure prior to placement.
 - 2. Erosion control blanket shall be of consistent thickness with fibers distributed evenly over the entire area of the blanket.
 - 3. Erosion control blanket shall be free of defects and voids that would interfere with proper installation or impair performance.
- C. Materials:
 - 1. Blend of 70 percent straw and 30 percent coconut fibers.
 - a. The straw fibers shall consist of straw with 75 percent of fibers greater than 4 inches in length, and certified weed seed free.
 - b. Product shall be 100 percent biodegradable.
 - c. The blended fibers shall be evenly distributed throughout the entire area of the blanket.
 - d. The top and bottom of each blanket is covered with biodegradable jute netting.
 - 2. Blanket performance requirements:
 - a. C factor: 0.15.
 - b. Shear stress: 2.0 lb/ft².
 - c. Velocity: 8.5 feet per second.
 - d. Functional longevity: Less than 24 months.
 - 3. Material characteristics:
 - a. Width: 8.0 feet.
 - b. Length: 112.5 feet.

- c. Area: 100.0 yard².
- d. Weight: 50.0 pounds.
- e. Mass per unit area: 0.50 lb/yd².
- f. Net openings: 0.5 inch by 1.0 inch.
- g. Minimum Index Values:

Index Property	Test Method	Value
Thickness	ASTM D6525	0.331 in (8.41 mm)
Light Penetration	ASTM D6567	5.8%
Mass per Unit Area	ASTM D6475	0.81 lb/yd ² (437 g/m ²)
MD-Tensile Strength Max.	ASTM D6818	321.6 lb/ft (4.69 kN/m)
TD-Tensile Strength Max.	ASTM D6818	159.6 lb/ft (2.33 kN/m)
MD-Elongation	ASTM D6818	4.1%
TD-Elongation	ASTM D6818	4.8%
Water Absorption	ASTM D5665	382%

- D. Staples:
 - 1. Staples shall be 100 percent biodegradable with a U-shaped top. Staples shall be a minimum 4 inch biodegradable staple for cohesive soils and 6 inches for non-cohesive soils.

PART 3 EXECUTION

3.01 PREPARATION AND INSTALLATION

- A. Provide erosion and sediment control systems.
 - 1. Construct in accordance with requirements as specified.
- B. No clearing, grubbing or rough cutting permitted until erosion and sediment control systems are in place, other than site work specifically directed by Project Manager to allow soil testing and surveying.
- C. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Project Manager to remove and discard existing system.
- D. Regularly inspect and repair or replace damaged components of erosion and sediment control systems as specified in this Section.
 - 1. Unless otherwise directed, maintain erosion and sediment control systems until project area stabilization is accepted by the Authority.
 - 2. Remove erosion and sediment control systems promptly when directed by Project Manager.
 - 3. Discard removed materials off site.

- E. Remove and dispose sediment deposits at designated spoil site for Project.
 - 1. If a project spoil site is not indicated on the Drawings, dispose of sediment off site at location not in or adjacent to stream or floodplain.
 - 2. Assume responsibility for off-site disposal.
 - 3. Spread sediment evenly throughout site, compacted and stabilized.
 - 4. Prevent sediment from flushing into a stream or drainage way.
 - 5. If sediment has been contaminated, dispose of in accordance with existing federal, state, and local rules and regulations.
- F. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8-inch layers.
 - 1. Compaction density shall be at a minimum of 90 percent Standard Proctor ASTM D698 density.
 - 2. Make at least 1 test per 500 cubic yards of embankment.
- G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights-of-way and easements for construction.
 - 1. Immediately repair damage caused by construction traffic to erosion and sediment control.

3.02 GENERAL CONSTRUCTION METHODS

- A. Provide erosion and sedimentation control systems.
 - 1. Install erosion and sedimentation control systems in manner that surface runoff shall percolate through system in sheet flow fashion and allow retention and accumulation of sediment.
- B. Inspect erosion and sedimentation control systems after each rainfall, daily during periods of prolonged rainfall, and at minimum once each week.
 - 1. Repair or replace damaged sections immediately.
 - 2. Remove sediment deposits when silt reaches depth 1/3 height of fence or 6 inches, whichever is less.

3.03 SITE PREPARATION FOR EROSION CONTROL BLANKETS

- A. Before placing erosion control blanket, Contractor shall certify that the subgrade has been properly compacted, graded smooth, has no depressions, voids, soft or uncompacted areas, is free from obstructions such as tree roots, protruding stones, or other foreign matter, and is seeded and fertilized according to project specifications.
 - 1. Contractor shall not proceed until all unsatisfactory conditions have been remedied.
 - 2. By beginning construction, Contractor signifies that the proceeding work is in conformance with this Section.
- B. Contractor shall fine grade the subgrade by hand dressing where necessary to remove local deviations.
- C. No vehicular traffic shall be permitted directly on the erosion control blanket.

- D. Slope installation
1. Erosion control blanket shall be installed as directed by Owner's representative in accordance with manufacturer's Installation Guidelines, Staple Pattern Guides, and CAD details.
 2. Erosion control blanket shall be oriented in vertical strips and anchored with staples, as identified in the Staple Pattern Guide.
 - a. Adjacent strips shall be overlapped to allow for installation of a common row of staples that anchor through the nettings of both blankets.
 - b. Horizontal joints between erosion control blankets shall be sufficiently overlapped with the uphill end on top for a common row of staples so that the staples anchor through the nettings of both blankets.
 3. Where exposed to overland sheet flow, a trench shall be located at the uphill termination erosion control blanket shall be stapled to the bottom of the trench.
 - a. The trench shall be backfilled and compacted.
 - b. Where feasible, the uphill end of the blanket shall be extended 3 feet over the crest of the slope.

3.04 FILTER FABRIC FENCE CONSTRUCTION METHODS

- A. Attach filter fabric to 1-inch by 2-inch wooden stakes or driven steel rods spaced a maximum of 3 feet apart and embedded minimum of 8 inches or deeper to hold fence in place.
1. If filter fabric is factory preassembled with support netting, then maximum spacing allowable is 8 feet.
 2. Install anchoring stakes or rods at slight angle toward source of anticipated runoff.
 3. Contractor is responsible for providing adequate fence anchoring appropriate for the varying soil and rock conditions at the well sites.
- B. Trench in toe of filter fabric fence with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow.
1. V-trench configuration may also be used.
 2. Lay filter fabric along edges of trench.
 3. Backfill and compact trench.
- C. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.
- D. Provide filter fabric in continuous rolls and cut to length of fence to minimize use of joints.
1. When joints are necessary, splice fabric together only at support post with minimum 6-inch overlap and seal securely.

3.05 TRIANGULAR FILTER FABRIC FENCE CONSTRUCTION METHODS

- A. Attach filter fabric to fence structure fashioned from 6 gauge, 6-inch by 6-inch wire mesh, 18 inches on each side.
1. Fabric cover and skirt should be continuous wrapping of fabric.
 2. Skirt should form continuous extension of fabric on upstream side of fence.

- B. Secure triangular fabric filter fence in place using one of the following methods:
 - 1. Toe-in skirt 6 inches with mechanically compacted material.
 - 2. Weight down skirt with continuous layer of 3-inch to 5-inch graded rock.
 - 3. Trench-in entire structure 4 inches.
- C. If provided, anchor triangular fabric filter fence structure and skirt securely in place using 6-inch wire staples on 2-foot centers on both edges and on skirt or staked using 18-inch by 3/8-inch diameter re-bar with tee ends.
- D. Lap over fabric filter material by 6 inches to cover segment joints.
 - 1. Fasten joints with galvanized shoat rings.

3.06 STRAW BALE FENCE CONSTRUCTION METHODS

- A. Bound bales with either wire, nylon or polypropylene rope tied across hay bales.
 - 1. Do not use jute or cotton bindings.
- B. Place bales in row with ends tightly abutting adjacent bales.
 - 1. Place bales with bindings parallel to ground surface.
- C. Embed bale in soil a minimum of 4 inches.
- D. Securely anchor bales in place by 3/8-inch rebar stakes driven through bales a minimum of 18 inches into ground.
 - 1. Angle first stake in each bale toward previously laid bale to force bales together.
- E. Fill gaps between bales with straw to prevent water from escaping between bales.
 - 1. Wedge carefully in order not to separate bales.
- F. Replace with new straw bale fence every 2 months.

3.07 BRUSH BERM CONSTRUCTION METHODS

- A. Construct brush berm along contour lines by hand placing method.
 - 1. Do not use machine placement of brush berm.
- B. Use woody brush and branches having diameter less than 2-inches with 6-inches overlap.
 - 1. Avoid incorporation of annual weeds and soil into brush berm.
- C. Use minimum height of 18-inches measured from top of existing ground at upslope toe to top of berm.
 - 1. Top width shall be 24 inches minimum and side slopes shall be 2:1 or flatter.
- D. Embed brush berm into soil a minimum of 4-inches and anchor using either wire, nylon, or polypropylene rope across berm with a minimum tension of 50 pounds.
 - 1. Tie rope securely to 18-inch x 3/8-inch diameter rebar stakes driven into ground on 4-foot centers on both sides of berm.

END OF SECTION

SECTION 01_60_00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Requirements for tangible materials, raw or manufactured, that become part of the project.

1.02 DEFINITIONS

- A. Certificates: Documents that the work is in accordance with the Contract Documents.
- B. Extra stock materials: Extra stock materials provided for the Owner's use in facility operation and maintenance.
- C. Manufacturer's instructions:
 - 1. Stipulations, directions, and/or recommendations issued form by the manufacturer of the product addressing handling, installation, erection, and/or application of the product.
- D. Products:
 - 1. Raw materials, finished goods, equipment, systems, and shop fabrications.
- E. Product data:
 - 1. Public information about the product which is found in the manufacturer's catalogs or on their web site including catalog pages, data sheets, bulletins, layout drawings, exploded views, and brochures.
- F. Samples:
 - 1. As defined in the General Conditions and Supplementary Conditions.
 - 2. Full-size actual products or pieces of products intended to illustrate the products to be incorporated into the project. Sample submittals are often necessary for such characteristics as colors, textures, and other appearance issues.
- G. Schedules:
 - 1. Product parts and materials lists.
- H. Shop drawings:
 - 1. As defined in the General Conditions and Supplementary Conditions.
 - 2. Shop drawings are prepared specifically for the project to illustrate details, dimensions, and other data necessary for satisfactory fabrication or construction that are not shown in the contract documents. Shop drawings could include graphic line-type drawings and single-line diagrams.

- I. Spare parts:
 - 1. Duplicate parts necessary to replace a damaged or worn part of the product.
 - 2. Consumables such as operating fluids.
- J. Special tools:
 - 1. Special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system 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.
- K. Submittals:
 - 1. As defined in the General Conditions and Supplementary Conditions.
 - 2. Samples, product data, shop drawings, and others that demonstrate how Contractor intends to conform to the Contract Documents.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide products by same manufacturer when products are of similar nature, unless otherwise specified.
- B. Provide like parts of duplicate units that are interchangeable.
- C. Provide equipment or product that has not been in service prior to delivery, except as required by tests.
- D. Provide products produced by manufacturers regularly engaged in the production of these products.
- E. Provide products that bear approvals and labels as specified.

2.02 MATERIAL

- A. Dissimilar metals:
 - 1. Separate contacting surfaces with dielectric material.
 - 2. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials as specified.
- B. Products in contact with drinking water or water in the process of becoming drinking water in accordance with NSF 60 or NSF 61 by an independent ANSI accredited third party.
- C. 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.
- D. Use anti-galling compound on threads of stainless steel fasteners during factory assembly.

- E. Provide anti-galling compound with stainless steel fasteners shipped for field assembly.
- F. Aluminum in contact with concrete or masonry: Apply epoxy mastic coating system.
- G. Provide new pipe manufactured for the project, not from manufacturer's inventory, under the following conditions:
 - 1. Pipes 24-inch diameter and larger.
 - 2. Pipe manufactured more than 6 months prior to delivery if the pipe material or its coating is subject to UV degradation.
 - 3. Ductile iron pipe with cement-mortar lining manufactured more than 6 months prior to delivery to the project.
 - 4. Steel pipe 6-inch diameter and larger.
- H. Mark each length of pipe in accordance with applicable standards.

2.03 PRODUCT SELECTION

- A. Provide products with Engineer approved submittals.
- B. When products are specified by standard or specification designations of technical societies, organizations, or associations only, provide products that meet or exceed reference standard and Specifications.
- C. When products are specified with names of manufacturers but no model numbers or catalog designations, provide Products by one of named manufacturers that meet or exceed Specifications.
- D. 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 named manufacturers.
- E. 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 one of named manufacturers proven, in accordance with requirements for an "or equal", including Engineer's approval, to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
- F. 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.

2.04 SHIPMENT

- A. Requirements prior to shipment of equipment:
 - 1. Engineer approved shop drawings.
 - 2. Engineer approved Manufacturer's Certificate of Source Testing as specified in the Technical Sections.
 - 3. Draft operations and maintenance manuals, as specified in Section 01_78_24 - Operation and Maintenance Manuals, when required by specifications.
- B. Prepare products for shipment by:
 - 1. Tagging or marking to agree with delivery schedule or shop drawings.
 - 2. Including complete packing lists and bills of material with each shipment.
 - 3. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
 - 4. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.
- C. Transport products by methods that avoid product damage.
- D. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

2.05 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 one set of special tools required to install or service the equipment.
- C. Box, tag, and clearly mark items.
- D. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by Owner.

PART 3 EXECUTION

3.01 DELIVERY AND HANDLING

- A. Handle equipment in accordance with manufacturer's instructions.
- B. Provide construction equipment and personnel to handle products by methods to prevent soiling or damage.
- C. Upon delivery, promptly inspect shipments:
 - 1. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.
 - 2. Acceptance of shipment does not constitute final acceptance of equipment.

- D. 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 enclosed, weather-proof, and lighted facility during the construction period.
 - a. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
 - 3. With Owner's written request for advanced delivery of spare parts, maintenance products, and special tools.
 - a. Deliver requested items and deduct them from the inventory list.
 - b. Provide transmittal documentation.
 - 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.
 - 4) Store smaller items in spare parts box:
 - d. Weight: Less than 50 pounds.
 - e. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
 - f. Clearly labeled:
 - 1) Equipment tag number.
 - 2) Equipment manufacturer.
 - 3) Subassembly component, if appropriate.
 - 4) Spare parts and special tools box:
 - g. Box material: Waterproof, corrosion resistant.
 - h. Hinged cover:
 - 1) Locking hasp.
 - i. Spare parts inventory list taped to underside of cover.
 - j. Clearly labeled:
 - 1) The words "Spare Parts and/or Special Tools".
 - 2) Equipment tag number.
 - 3) Equipment manufacturer.
 - 4) Subassembly component, if appropriate.

3.02 STORAGE AND PROTECTION

- A. Immediately store and protect products until installed in Work.
- B. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for mechanical equipment, valves, and special equipment to be incorporated into this project.
 - 1. Storage of equipment shall be in strict accordance with the "instructions for storage" provided by the manufacturer.
 - a. Including connection of heaters, lubrication, rotating shafts, etc.
 - 2. The Contractor shall furnish a copy of the manufacturer's instructions for storage to the Engineer prior to storage of equipment and materials.
- C. Store products with seals and legible labels intact.

- D. Protect painted or coated surfaces against impact, abrasion, discoloration, and damage.
 - 1. Repaint or recoat damaged painted or coated surfaces.
- E. 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.
- F. Store moisture sensitive products in watertight enclosures.
- G. Store loose granular materials on solid surfaces in well-drained area.
 - 1. Prevent materials mixing with foreign matter.
 - 2. Provide access for inspection.
- H. 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.
- I. Payment will not be made for equipment and materials improperly stored or stored without providing Engineer with the manufacturer's instructions for storage.
- J. Provide an equipment log and stored products log with monthly pay applications.
 - 1. Data includes as a minimum: The 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.

3.03 INSTALLATION

- A. Inspect hardware or fittings prior to product installation.
- B. Use anti-galling compound on stainless steel threads used for field assembly.

3.04 PROTECTION AFTER INSTALLATION

- A. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations.
 - 1. Remove covering when no longer needed.
 - 2. Replace corroded, damaged, or deteriorated equipment, product, or parts 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 01_71_23
FIELD ENGINEERING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Field engineering to establish lines and grades for the Work.

1.02 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Qualifications of the professional land surveyor or registered civil engineer in the state where project is located that will be performing the field engineering.
- C. Pre-Excavation Report.

1.03 PRE-EXCAVATION REPORT

- A. Prior to the start of the Work, create a report confirming the verification of the following data:
 - 1. Site elevation.
 - 2. Existing structures including but not limited to buildings, manholes (sanitary, storm, electrical, and other), drainage inlets:
 - a. Location coordinates.
 - b. Top of wall elevation and coordinates.
 - c. Floor elevations.
 - d. Invert elevations.
 - 3. Existing utilities.
 - 4. Proposed structures corners, tank, and equipment locations.
 - 5. Verify existing electrical, instrumentation, and phone utilities.
- B. Incorporate information from Pre-Excavation Report into the record drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SURVEY REFERENCE POINTS

- A. Basic reference line, a beginning point on basic reference line, and a benchmark will be provided by Owner.
- B. From these reference points, establish other control and reference points as required to properly lay out the Work.

- C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
 - 1. Make no changes or relocations without prior written notice.
 - 2. Replace Project control point, when lost or destroyed, in accordance with original survey control.
- D. Set monuments for principal control points and protect them from being disturbed and displaced:
 - 1. Re-establish disturbed monuments.
 - 2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

3.02 PROJECT SITE SURVEY REQUIREMENTS

- A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.
- B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.
- C. Perform verifications and checking in accordance with standard surveying practice.
- D. Maintain complete, accurate log of control points and survey.
- E. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

3.03 CONSTRUCTION STAKES, LINES, AND GRADES

- A. Execute the Work in accordance with the lines and grades indicated.
- B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

3.04 QUALITY CONTROL

- A. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer:
 - 1. Notice of when checking will be conducted will be given.
 - 2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
 - 3. Engineer's check does not substitute or complement required field quality control procedures.

3.05 RECORD DOCUMENTS

- A. Prepare and submit Record Documents as specified in Section 01_77_00 - Closeout Procedures.
- B. Provide certified site survey including buildings, benchmarks, and appurtenances sealed and signed by professional land surveyor or registered civil engineer.
 - 1. File with permitting agency, as required.

END OF SECTION

SECTION 01_77_00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: 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. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
 - 1. Police yards and grounds to keep clean.
- F. Remove dust, cobwebs, and traces of insects and dirt.
- G. 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.
- H. Remove non-permanent protection and labels.
- I. 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 Owner of such property.
- B. Do not create unsightly or unsanitary nuisances during disposal operations.

- C. Maintain disposal site in safe condition and good appearance.
- D. 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 CLOSEOUT DOCUMENTS

- A. Submit the following Closeout Submittals at 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 Closeout Submittals before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
 - 1. Punch list of items have been completed and 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 01_32_21 - Schedules and Reports.

1.07 PROJECT RECORD DOCUMENTS

- A. Upon completion of the work, the contractor shall supply the engineer with a reproducible record drawing of the final conveyance and wellhead system. The drawings shall show diameters and depths and other information that may be required by the engineer and regulatory agencies, including wellhead details. The record drawing shall be prepared, signed, and sealed by a professional engineer licensed to practice in the State of Florida.
- B. Maintain at Project site, available to 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 conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue
Dimensions:	Graphite

- C. Maintain documents separate from those used for construction:
 1. Label documents "RECORD DOCUMENTS."
- D. 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.
- E. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.
- F. Deliver Record Documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.
- G. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.
- H. Updated Record Documents are a condition for Engineer's recommendation for progress payment.
- I. Final Schedule Submittal as specified in Section 01_32_21 - Schedules and Reports.

1.08 MAINTENANCE SERVICE

- A. Maintenance service as specified in technical specifications.

1.09 SUBSTANTIAL COMPLETION

- A. Obtain Certificate of Substantial Completion.

1.10 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 conduct 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.

1.11 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.

1.12 FINAL APPLICATION FOR PAYMENT

- A. Contractor shall submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

PART 2 PRODUCTS

2.01 SPARE PARTS

- A. Owner may request advanced delivery of spare parts, maintenance products, and special tools.
 - 1. Deduct the items delivered from the inventory list and provide transmittal documentation.
- B. 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 01_78_24

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Preparation and submittal of Operation and Maintenance Manuals.

1.02 GENERAL

- A. Submit Operation and Maintenance Manuals as specified in technical sections.

1.03 SUBMITTALS

- A. Make approved manuals available at project site for use by construction personnel and Owner.
- B. Draft Operation and Maintenance Manuals:
 - 1. Submit prior to shipment of equipment or system to site.
 - 2. Shipment will be considered incomplete without the draft Operation and Maintenance Manuals.
 - 3. Quantity:
 - a. Hard copy: 4 sets.
 - b. Electronic: 2 USB flash drive.
- C. Final Operation and Maintenance Manuals:
 - 1. Make additions and revisions in accordance with Owner's and Engineer's review comments on draft manuals.
 - 2. Submit approved Operation and Maintenance Manuals at least 30 days prior to Functional Testing and at least 60 days prior to Owner Training.
 - 3. Quantity:
 - a. Hard copy: 4 sets.
 - b. Electronic: 2 USB flash drive.

1.04 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 larger sizes.
 - 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 MicroStation/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.

1.05 CONTENTS

- A. Label the spines:
 1. Equipment name.
 2. Tag number.
 3. Project name.
 4. Owner name.
- B. Cover page:
 1. Operation and Maintenance Manual.
 2. Equipment name.
 3. Specification Section Number
 4. Equipment tag number.
 5. Owner's name.
 6. Project number and name.
 7. Date.
- C. Table of Contents: General description of information provided within each tab section.
- D. Complete Attachment A - Equipment Summary Form.
- E. Complete Attachment B - Electric Motor Technical Data Form.
- F. Description of system and components.
 1. Valves:
 - a. Each type of manual valve 4 inches in nominal size and larger.
 - b. Non-manual valves.
 - c. Operators.
- G. Description of equipment function, normal operating characteristics, and limiting conditions.
- H. Manufacturer's product data sheets:
 1. Where printed material covers more than 1 specific model, indicate the model number, calibrated range, and other special features.

- 2. Equipment with bearings:
 - a. Include manufacturer and model number of every bearing.
 - b. Include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.
- I. Assembly, installation, alignment, adjustment, and checking instructions.
- J. Storage instructions.
- K. Control diagrams:
 - 1. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.
 - 2. Complete set of 11-inch by 17-inch drawings of the control system.
 - 3. Complete set of control schematics.
- L. Programming: Copies of Contractor furnished programming.
- M. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.
- N. 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. Manual keyboard entries.
 - d. Entry codes.
 - e. System responses.
 - f. Other information as needed for safe system operation and maintenance.
 - 2. Modes:
 - a. Startup.
 - b. Routine and normal operation.
 - c. Regulation and control.
 - d. Shutdown under specified modes of operation.
 - e. Emergency operating shutdown.
- O. Preventative maintenance procedures:
 - 1. Recommended steps and schedules for maintaining equipment.
 - 2. Troubleshooting.
- P. Lubrication information: Required lubricants and lubrication schedules.
- Q. 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.
- R. Parts list:
 - 1. Complete parts list for equipment including but not limited to the following information:

2. Catalog data: Generic title and identification number of each component part of equipment.
 3. Include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
 4. Availability.
 5. Service locations.
- S. Spare parts list: Recommended number of parts to be stored at the site and special storage precautions.
- T. Engineering data:
1. Drawings: Complete set of 11-inch by 17-inch equipment drawings.
 2. Exploded view or plan and section views with detailed callouts.
 3. Outline, cross-section, and assembly drawings.
 4. System drawings and data sheets: Include drawings and data furnished by the Engineer and the Supplier; provide "as installed" version.
- U. Test data and performance curves, when applicable.
- V. Manufacturer's technical reference manuals.
- W. Source (factory) Test results: Provide copies of Source Tests reports as specified in technical sections.
- X. Functional Test results: After Functional Tests are completed, insert Functional Test reports as specified in technical sections.

1.06 ARCHIVAL DOCUMENTATION

- A. Typically does not require updating to remain valid and should be stored in a format that preserves the document and limits one's ability to make changes.
- B. Types of archival documents include the following:
1. Record drawings.
 2. Reports.
 3. Specifications.
 4. Shop drawings.
 5. Vendor Equipment O & M Manuals.
 6. Photos.
 7. Demonstration and training videos.
 8. Other.

1.07 LIVING DOCUMENTATION

- A. Requires periodic updates to remain valid and should be stored in formats that are easy to update.
- B. Types of living documents include the following:
1. Facility O&M Manuals.
 2. Standard Operating Procedures.
 3. Other.

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 IDENTIFICATION NUMBER(S) _____
(maps equipment number)
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: _____

ATTACHMENT B - ELECTRIC MOTOR TECHNICAL DATA

ELECTRIC MOTOR TECHNICAL DATA

Technical Data for Each Motor:

Application: _____

Manufacturer: _____

Frame No.: _____ Type: _____

Code Letter: _____ Design Letter: _____

Rating:

Horsepower: _____ Voltage: _____ Phase: _____

Cycles: _____ Full Load rpm: _____
(wound rotor secondary)

Volts: _____ Amperes: _____

Full Load Current: _____ amperes

Locked Rotor Current: _____ amperes

Locked Rotor or Starting Torque (percent of full load): _____ percent

Full Load Torque: _____ ft-lb

Breakdown Torque: _____ percent

Efficiency:

Full Load: _____ percent

3/4 Load: _____ percent

1/2 Load: _____ percent

Power Factor:

Full Load _____ percent

3/4 Load: _____ percent

1/2 Load: _____ percent

Insulation:

Type: _____

Class: _____

Temperature Rise: _____ Above Ambient: _____

Enclosure: _____

Net Weight: _____ lbs

Wk²: _____ lbs/sq ft

Type of Bearings: _____

Service Factor: _____

Noise Level in Decibels: _____

Heaters: _____ kW, _____ Phase, _____ volts

Altitude: _____

SECTION 01_78_36
WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: 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 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 Owner.
- 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.
 - 1. When correcting warranted Work that has failed, remove, and replace other Work that had been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- 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.
 - 2. In the case that Owner has to provide temporary equipment to replace function of warranted item requiring repair or replacement, manufacturer shall reimburse Owner for such costs associated with the temporary equipment.
- E. Warranty commences 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 specified in the section where the item is specified.
 - 1. Includes Project-specific information and requirements, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Owner. Technical sections indicate Project-specific requirements that differ from the minimum warranty requirements for that item.
 - a. Examples include extending the duration of manufacturer's warranty or to provide increased rights to Owner.
 - 2. Manufacturer's warranties commence on the date that the associated item is certified by Engineer as substantially complete.

1.07 WARRANTY WORK

- A. Guarantee:
 - 1. The Contractor guarantees that the work and service to be performed under the contract and all workmanship, materials, and equipment performed, furnished, used, or installed in the work shall be free from defects and flaws, and shall be performed and furnished in strict accordance with the contract documents; that the strength of all parts of all manufactured equipment shall be adequate and as specified; and that performance test requirements of the contract documents shall be fulfilled. The Contractor shall guarantee that all work will be performed in a workmanlike manner by qualified subcontractors experienced in the type of conditions to be encountered. The Contractor shall repair, correct, or replace all damage to the work resulting from failures covered by the guarantee for one year from the date of final acceptance by the Owner.
- B. 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.
- C. 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.
- D. 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.
- E. 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.
- F. 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 01_81_50

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. 7-22 - 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).

1.03 SUBMITTALS

- A. Submit documentation of Contractor-prepared designs as specified in Technical Sections of the Contract Documents.
 - 1. Calculations:
 - a. Where submittal of calculations is required:
 - 1) Provide complete calculations, including sketches to illustrate the design concepts being evaluated, and details to fully describe proposed construction.

2. Shop drawings:
 - a. Shop drawings describing components and manufacturer's requirements for connections.
 - 1) Include details for connections of components to structures and supports
 - 2) Include details for anchoring bracing to structures where required.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA - SITE INFORMATION

- A. Site name: Northeast WRF and WTP.
 1. Location:
 - a. Street Address: 825 39th Ave., Naples, FL.
 - b. Elevation (approximate):
 - 1) 17 above mean sea level.

2.02 DESIGN CRITERIA - REGULATORY REQUIREMENTS

- A. Requirements of authorities having jurisdiction over the project are included in Section 01_41_00 - Regulatory Requirements.

2.03 DESIGN CRITERIA - OPERATING ENVIRONMENT

- A. Project conditions:
 1. Equipment and materials for the Work shall be suitable for:
 - a. Outdoor use.
 2. The Drawings and Technical Sections include additional criteria and requirements relevant to specific locations, materials, and equipment.
 3. Rainfall intensity:
 - a. Reference: NOAA Precipitation Frequency Data Server
 - 1) 4.9 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.

- B. Groundwater elevation:
 - 1. For design of buried and partially buried construction:
 - a. Groundwater is expected to be below the level of construction.
- 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 01_41_00 - Regulatory Requirements, based on the Structure Risk Category indicated in Table: Project Structures - Risk Category
- D. Seismic loads:
 - 1. Seismic design parameters: Basic parameters - ASCE 7:
 - a. Ground motion MCE_R , 5 percent damped:
 - 1) Short periods, $S_s = 0.054$ g.
 - 2) One second period, $S_1 = 0.023$ g.
 - b. Peak ground acceleration, MCE_G :
 - 1) Peak ground acceleration, $PGA = 0.028$ g.
 - c. Mapped long-period transition period:
 - 1) $TL = 8$ seconds.
 - 2. Structures - General:
 - a. Seismic Design Category (SDC): As indicated in the following Table: Project Structures - Risk Category and Seismic Design Information.

Table: Project Structures - Risk Category and Seismic Design Information						
Description: Water Treatment Facility						
Area	Description	Risk Category	Site Class	S_Ds	S_{D1}	Seismic Design Category⁽¹⁾
Injection Wells	Concrete Slab with above grade piping and equipment.	III	D	0.05	0.033	A
Monitoring Well	Concrete Slab with above grade piping and equipment.	III	D	0.05	0.033	A

Notes:

(1) Seismic Design Category for delegated design, and for seismic certification of electrical and mechanical equipment as required by ASCE 7. For this seismic design category, no seismic design is required.

- 2) In accordance with ASCE 7, and the requirements of the Technical Sections.
- 3. Non-structural components - General:
 - a. Includes:
 - 1) Mechanical and electrical equipment; anchorage of equipment to structures or supports; design of equipment supports; and anchorage of supports to structures or foundations.

- 2) Distribution systems associated with mechanical and electrical equipment such as piping, ductwork, conduits, cable trays, raceways, bus ducts, and similar items; anchorage of such systems to supports and structures; and bracing or such systems.
- b. Seismic design requirements for non-structural components are based on the Seismic Design Category (SDC) of the structure or facility where the equipment is installed.
 - 1) See Table: Project Structures - Risk Category and Seismic Design Information for Seismic Design Categories of facilities or structures included in the Work.
- c. Component importance factor, I_p :
 - 1) In accordance with the following Table: Component Importance Factor for seismic design, I_p .

Table: Component Importance Factor for seismic design, I_p		
Structure Seismic Design Category	Components	I_p
All	Electrical: Items and distribution system components specified in Division 26 – Electrical and other equipment not listed.. No seismic design required.	10

- E. 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) 168 miles per hour (33 feet, 3 second gust).
 - b. Exposure category: C.
 - c. Risk Category: III
 - d. Topographic factor, K_{zt} : 1.0.
- F. Rainfall loads:
 1. Determine rainfall loads using rainfall intensity specified herein, and including effects of exposed surface slope, height above surface to discharge elevation, and deflection of ponded surfaces.
- G. 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 equipment manufacturer.
 3. Design for loads indicated in the Technical Sections for equipment and appurtenances.

- H. Serviceability considerations:
 - 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 in accordance with the requirements of:
 - 1. Regulatory requirements, including but not limited to the building code specified in Section 01_41_00 - Regulatory Requirements; AND
 - 2. Reference standards and project-specific design criteria listed in this Section and Specific requirements for individual elements and components of the Work as specified in subsequent Technical Sections.
- B. Designs based on criteria in this Section shall not be less than what is required to comply with the codes and standards specified in Section 01_41_00 - Regulatory Requirements.
- C. In the event of conflicts between design criteria, contact Engineer for interpretation.
- D. Prepare and submit designs for the following, and where Owner-delegated design is required by the Specifications.
 - 1. Design, detailing, and anchoring of pre-engineered structures.
 - 2. Design, detailing, and anchoring of pre-engineered structural components.
 - 3. Anchoring of equipment and components to structures.
 - 4. Bracing of equipment and components from structures.
 - 5. Anchoring and bracing for distribution systems attached to or braced from structures.
- E. Requirements for seismic design calculations will be waived for all components.
- F. Requirements for wind design calculations will be waived for the following:
 - 1. Equipment and components located inside structures, and away from the effects of wind loads.

3.02 DESIGN - ANCHORS FOR EQUIPMENT, COMPONENTS, AND BRACING

- A. General:
 - 1. Complete, submit, and obtain Engineer's approval of anchor designs after approval of equipment and before placement of concrete or masonry that will support or provide bracing for the equipment.
 - 2. Adjust equipment pad sizes and add additional anchorage confinement reinforcing to provide required strength at anchorage points.
 - 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. Layout and location of anchors that connect to equipment base plates, sole plates, or skids.
 - b. 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, sloshing, surge, and water hammer.
 - 2) Equipment reactions and operating torque.
 - 3) Equipment vibration.
 - 4) Thermal effects from equipment and from attached distribution systems.
 - 5) Other load or displacement inducing conditions.
 - d. Forces on equipment from piping and electrical connections.
 - e. Forces on equipment from loads specified in this Section:
 - 1) Include effects of wind, snow, and icing loads where applicable based on location of the equipment in the Work.
 - 2) Design for load combinations indicated in ASCE 7, unless otherwise specified or indicated on the Drawings.
 - 3) wind loads: For equipment and tanks having varying weight 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 shears and associated axial forces at each anchor.
 - 4. Do not use friction to resist sliding resulting from wind forces. Resist 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 seismic and 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 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: $f'_c = 4,500$ 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 03_15_14

HYDROPHILIC RUBBER WATERSTOP

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Hydrophilic rubber waterstop.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - 2. D570 - Standard Test Method for Water Absorption of Plastics.
 - 3. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 4. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.

1.03 SUBMITTALS

- A. General:
 - 1. Submit the following items for each type, style, and size of hydrophilic waterstop to be installed.
 - 2. Product data:
 - a. Manufacturer's product data sheets.
 - 1) Include complete physical dimensions, expansion characteristics, and laboratory test reports indicating that average material properties conform to the requirements specified.
 - 2) Provide data sheets for all materials to be included in the waterstop system.
 - 3. Samples:
 - a. Minimum 6-inch long samples of each type of waterstop to be used if requested by the Engineer.
 - 4. Manufacturer's installation instructions:
 - a. Installation instructions and recommended installation details for the complete waterstop system, and for each component used in that system.

PART 2 PRODUCTS

2.01 HYDROPHILIC RUBBER WATERSTOP

- A. General:
 - 1. System composed of flexible hydrophilic urethane polymer with preformed strips, adhesives, paste, fasteners, and other accessories required for a complete and watertight installation.

- a. To ensure compatibility of materials, a single manufacturer shall provide all products and accessories for the hydrophilic waterstop system.
 - b. Products incorporating bentonite are not acceptable under this Section.
 - c. Provide waterstop and accessories resistant to degradation under cyclic wetting and drying.
- B. Hydrophilic strip waterstop:
 - 1. Pre-formed strips of flexible hydrophilic rubber designed to undergo controlled expansion when exposed to moisture:
 - a. Strips manufactured to limit expansion in directions parallel to the plane of the joint, and to direct expansion against confining material perpendicular to that plane.
 - 2. Provide normal or low-expansion pressure as scheduled and as indicated on the Drawings.
 - 3. Manufacturers: One of the following or equal:
 - a. Hydrophilic strip:
 - 1) Adeka Ultra Seal USA, MC-2010MN.
 - 2) Sika Corp., Hydrotite CJ1020-2K.
 - b. Low expansion hydrophilic strip:
 - 1) Adeka Ultra Seal USA, KBA-1510FP.
 - 2) Sika Corp., Hydrotite CJ0725-3K.
- C. Hydrophilic paste waterstop.
 - 1. Single-component gun grade paste of hydrophilic rubber designed to undergo controlled expansion when exposed to moisture after initial curing.
 - 2. Manufacturers: One of the following or equal:
 - a. Adeka Ultra Seal USA: P-201.
 - b. Sika Corp., Leakmaster LV-Z.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions and recommended details.
- B. Prepare concrete joint surfaces:
 - 1. Use wire brushing or scraping to expose an uncontaminated, solid surface.
 - 2. Clean prepared surface with high-pressure air or water to remove residue and debris.
 - 3. Confirm that prepared surfaces conform to manufacturer's recommendations for surface profile and moisture conditions before installing materials.
- C. Provide manufacturer's recommended lap, splice, and corner details for hydrophilic waterstops.
 - 1. Use hydrophilic paste at all corner joints and overlap splices of hydrophilic strips.

- D. Hydrophilic strip waterstop:
1. Install primers and adhesives when recommended by the manufacturer before setting hydrophilic strips.
 2. Keep hydrophilic strip taut during the fastening process.
 3. Secure hydrophilic strip in place with concrete nails, screws, or adhesive.
 4. Provide installation with no gap between the hydrophilic strip and the concrete to which it is attached. At rough or irregular surfaces, set hydrophilic strip waterstop strip in a bead of hydrophilic paste.
 - a. Fill all voids and rough areas under the hydrophilic strip with hydrophilic paste.
 - b. Allow hydrophilic paste to cure in accordance with manufacturer's recommendations before encapsulating paste in fresh concrete.

3.02 SCHEDULE

- A. At the following joint locations/conditions, use the hydrophilic strip waterstop configuration noted unless otherwise indicated on the Drawings.
- B. Concrete construction joints:
1. Under all of the following conditions, use hydrophilic strip waterstop set in a bed of hydrophilic paste waterstop, and screw strip waterstop to concrete surface:
 - a. Slab or wall thickness is greater than 10 inches.
 - b. Waterstop is placed between 2 rows of steel reinforcement.
 - c. Concrete cover from waterstop to nearest concrete face is at least 4 inches.
 2. Under any one of the following conditions, use low-expansion hydrophilic strip waterstop set in bed of hydrophilic paste waterstop and screw strip to concrete surface:
 - a. Waterstop is placed on 1 side of a single row of steel reinforcement.
 - b. Concrete cover from waterstop to nearest concrete face is less than 4 inches.
- C. Pipe penetrations through concrete:
1. Pipe diameter less than 4 inches: Not allowed.
 2. Pipe diameter of 4 to 24 inches: Continuous bead of hydrophilic paste waterstop, minimum 1/4-inch high by 1/2-inch wide, encircling pipe.
 3. Pipe diameter greater than 24 inches: Continuous hydrophilic strip waterstop around perimeter of pipe, with hydrophilic paste seal at lapped ends of strip.

END OF SECTION

SECTION 03_21_17

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.
- B. American National Standards Institute (ANSI):
 - 1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.
- C. ASTM international (ASTM):
 - 1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- D. Concrete Reinforcing Steel Institute (CRSI).
- E. ICC Evaluation Service, Inc. (ICC-ES):
 - 1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- F. Society for Protective Coatings (SSPC):
 - 1. SP-1 - Solvent Cleaning.

1.03 DEFINITIONS

- A. Evaluation Service Report (ESR): Report prepared by ICC-ES, or other testing agency acceptable to Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and to document its acceptance for use under the Building Code specified in Section 01_41_00 - Regulatory Requirements.

1.04 SUBMITTALS

- A. Product data: Technical data for adhesives, including:
 - 1. Manufacturer's printed installation instructions (MPII).

2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
 3. Handling and storage instructions.
- B. Quality control submittals:
1. Special inspection: Detailed step-by-step instructions for the special inspection procedures required by the building code specified in Section 01_41_00 - Regulatory Requirements.
 2. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
 3. Installer qualifications:
 - a. Submit evidence of successful completion of adhesive manufacturer's installation training program.
 - b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.
- C. Inspection and testing reports:
1. Inspections: Field quality control: Reports of inspections and tests.
 - a. Inspections: Field quality assurance: Reports of special inspections and tests.

1.05 QUALITY ASSURANCE

- A. Qualifications:
1. Installation requirements:
 - a. Have available at the site, and install anchors in accordance with, the adhesive manufacturer's printed installation instructions.
 2. Installer qualifications:
 - a. Demonstrating successful completion of adhesive manufacturer's on-site training program for installation of adhesive-bonded anchors.
 - b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the Building Official.
 - 1) Organizations/certification programs deemed to be qualified are:
 - a) ACI-CRSI Adhesive Anchor Installer Certification Program.
 - b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the Building Official.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
1. Store adhesives and adhesive components on pallets or shelving in a covered-storage area protected from weather.

2. Control temperature to maintain storage within manufacturer's recommended temperature range.
 - a. If products have been stored at temperatures outside manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.
- B. Seismic Design Category (SDC) for structures: As specified in Section 01_81_50 - Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

- A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.
- B. Adhesives shall have a current Evaluation Report documenting testing and compliance with the requirements or ACI 355.4 and of ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the Seismic Design Category specified.
- C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

2.02 EPOXY ADHESIVE

- A. Materials:
 1. Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
 2. 2-component, 100 percent solids, insensitive to moisture.
 3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.
- B. Packaging:
 1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
 - a. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
 - b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.

2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- C. Manufacturers: One of the following or equal:
1. Hilti, Inc., HIT-RE 500-V3.
 2. Simpson Strong-Tie Co., Inc., SET-XP.

2.03 ALL THREAD RODS

- A. Carbon steel:
1. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
 2. Nuts: ASTM A194.
 3. Washers: ASTM F436.
- B. Galvanized carbon steel:
1. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
 2. Nuts: ASTM A194, hot-dip galvanized in accordance with ASTM A153.
 3. Washers: ASTM F436, hot-dip galvanized in accordance with ASTM A153.
- C. Stainless steel:
1. Units descaled, pickled, and passivated.
 2. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
 3. Alloy Type 316 unless note otherwise.
 4. Type 304:
 - a. Rod: ASTM F593, Group 1, Condition CW, coarse threads.
 - b. Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
 - c. Washers: Type 304 stainless steel.
 5. Type 316:
 - a. Rod: ASTM F593, Group 2, Condition CW, coarse threads.
 - b. Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
 - c. Washers: Type 316 stainless steel.

2.04 REINFORCING BARS

- A. As specified in Section 03_30_01 - Concrete Work.

PART 3 EXECUTION

3.01 GENERAL

- A. Execution of this work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under Quality Assurance and accepted by the Engineer and the Building Official.
1. Do not install holes or adhesive until training is complete.

- B. Perform work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.
- C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings.
 - 1. If embedment depth is not indicated, contact Engineer for requirements.
 - 2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by Engineer.

3.02 PREPARATION

- A. Do not begin installation of adhesive bonded anchors until:
 - 1. Concrete has achieved an age of at least 21 days after placement.
 - 2. On-site training in installation of adhesive bonded anchors by manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.
- B. Review manufacturer's printed installation instructions (MPII) and "conditions of use" stipulated in the Evaluation Report before beginning work.
 - 1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents and resolve before proceeding with installation.
- C. Install adhesive bonded anchors in full compliance with manufacturer's printed installation instructions using personnel who have successfully completed manufacturer's on-site training for products to be used and who hold certifications specified in this Section.
- D. Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended range for temperature and moisture conditions, and will remain so during the curing time for the product.

3.03 HOLE SIZING AND INSTALLATION

- A. Drilling holes:
 - 1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
 - 2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by Engineer.
- B. Hole drilling equipment:
 - 1. Electric or pneumatic rotary impact type with medium or light impact.
 - a. Installation of anchors in cored holes is not permitted.
 - b. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with the manufacturer's installation instructions and the requirements of the Evaluation Report.

- c. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
- 2. Drill bits: Carbide-tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacturer or required as a "condition of use" in the Evaluation Report.
 - a. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.
- C. Hole diameter: As recommended in the manufacturer's installation instructions and the Evaluation Report.
- D. Hole depth: As recommended in the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.
- E. Obstructions in drill path:
 - 1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
 - a. Obtain Engineer's acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
 - b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
 - c. Epoxy grout may be substituted for dry-pack mortar when accepted by Engineer.
 - 2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
 - 3. When existing reinforcing steel is encountered during drilling and when specifically accepted by Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
 - 4. Bent bar reinforcing bars: Where edge distances are critical, and interference with existing reinforcing steel is likely, if acceptable to Engineer, drill hole at 10 degree (or less) angle from axis of reinforcing bar or all thread rod being installed.
- F. Cleaning holes:
 - 1. Insert air nozzle to bottom of hole and blow out loose dust.
 - a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
 - b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.

2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
 - a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
 - b. Repeat at least 4 times.
3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
4. Leave prepared holes clean and dry.
5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

- A. Clean and prepare inserts reinforcing bars and all thread rods:
 1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
 2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.
- B. Fill holes with adhesive:
 1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
 2. Fill hole as nozzle is withdrawn without creating air voids.
 3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
 4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.
- C. Installing reinforcing bars and all thread rods:
 1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
 2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer's recommended procedures.
 3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
 4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
 5. Clean excess adhesive from the mouth of the hole.

- D. Curing and loading:
 - 1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
 - 2. Do not disturb or load bonded embeds until manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.05 POST-INSTALLATION ACTIVITIES

- A. Do not bend bars or all-thread rods after bonding to the concrete, unless accepted in advance by the Engineer.
- B. Attachments to all thread rods:
 - 1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
 - 2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel to steel connections.

3.06 FIELD QUALITY CONTROL

- A. Provide field quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.
- B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.
- C. Manufacturer's services:
 - 1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
 - a. Provide notice of scheduled training to Engineer and to Special Inspector(s) not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
 - 2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.
- D. Field inspections and testing:
 - 1. Hole drilling and preparation.
 - 2. Results: Submit records of inspections and testing to Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

- A. Provide field quality assurance over the Work of this Section as specified in Section 01_45_00 - Quality Control.
- B. Special inspections, special tests, and structural observation:
 - 1. Provide as specified in Section 01_45_24 - Regulatory Quality Assurance.

2. Frequency of inspections:
 - a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
 - b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rods. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
3. Preparation:
 - a. Review Drawings and Specifications for the Work to be observed.
 - b. Review adhesive manufacturer's MPPI and recommended installation procedures.
 - c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
4. Inspection: Periodic:
 - a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.
 - 1) Concrete: Class (minimum specified compressive strength) and thickness.
 - 2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
 - 3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPPI, and the "conditions of use" listed in the Evaluation Report.
 - 4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.
 - 5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.
 - b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
 - 1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
 - 2) For ongoing installations, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.
5. Inspection: Continuous.
 - a. Make observations as described under "Inspection - Periodic, Initial Inspection" during all drilling, cleaning, and bonding activities for all bars and rods installed.

6. Records of inspections:
 - a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
 - b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03_30_01

CONCRETE WORK

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PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Concrete formwork; concrete accessories; concrete reinforcement; batching and mixing of concrete to be cast-in-place; concrete placement and curing; and tooled concrete finishes.

1.02 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. 305 - Specification for Hot Weather Concreting.
 - 3. 306 - Standard Specification for Cold Weather Concreting.
 - 4. 318 - Building Code Requirements for Structural Concrete and Commentary.
 - 5. SP-66 - ACI Detailing Manual.
- B. ASTM International (ASTM):
 - 1. A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 2. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 3. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 4. C33 - Standard Specification for Concrete Aggregates.
 - 5. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 6. C94 - Standard Specification for Ready-Mixed Concrete.
 - 7. C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
 - 8. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - 9. C150 - Standard Specification for Portland Cement.
 - 10. C156 - Standard Test Method for Water Loss from a Mortar Specimen Through Liquid Membrane-Forming Curing Compounds for Concrete.
 - 11. C171 - Standard Specification for Sheet Materials for Curing Concrete.
 - 12. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 - 13. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 14. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - 15. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 16. C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
 - 17. C494 - Standard Specification for Chemical Admixtures for Concrete.
 - 18. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - 19. C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - 20. C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.

21. C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
22. C1293- Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
23. C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
24. C1778 - Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete.
25. C1260 - Standard Test Method of Potential Alkali Reactivity of Aggregates (Mortar Bar Method).
26. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
27. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
28. D2103 - Standard Specification for Polyethylene Film and Sheeting.

- C. Concrete Reinforcing Steel Institute (CRSI):
1. Manual of Standard Practice.

1.03 DEFINITIONS

- A. Alkali load: Amount of alkalies contributed by the portland cement in a concrete mixture, expressed in lb/yd³, and calculated by multiplying the portland cement content of the concrete in lb/yd³ by the alkali content of the portland cement; or the portland cement portion of a blended cement, divided by 100.
- B. Average daily temperature: The average of the highest and lowest temperatures during a 24-hour period from midnight to midnight.
- C. Green concrete: Concrete whose current compressive strength is less than 100 percent of the minimum specified compressive strength, f'c.
- D. Hand mixed concrete: Concrete mixed at or near the point of placement using shovels, hoes, or other similar manually operated tools.
- E. Hot weather: A period when project conditions such as low humidity, high temperature, solar radiation, and high winds promote rapid drying of freshly placed concrete.
- F. Neat cement grout: Grout made from a mixture of portland cement and water.
- G. Supplementary cementitious material: inorganic material such as fly ash, natural pozzolans, silica fume, or slag cement that reacts pozzolanically or hydraulically.

1.04 SUBMITTALS

- A. General:
 1. Submittal as specified in Section 01_33_00 - Submittal Procedures unless modified in this Section.

- B. Product data:
1. Formwork:
 - a. Formwork facing materials. Data on facing materials for concrete exposed to view in the finished work, if different from that specified in this Section.
 - b. Form release agent. Manufacturer's name and catalog data.
 2. Joint materials:
 - a. Preformed expansion joint material: Manufacturer's name and catalog data with documentation of conformance to materials standards specified for each type and thickness of material.
 3. Reinforcement:
 - a. Mill certificates for each heat of steel provided.
 - b. Reinforcement placement drawings:
 - 1) Show anchor bolt locations based on anchor bolt templates for approved equipment.
 - c. Concrete bar supports:
 - 1) Precast concrete bar supports ("dobies"): Manufacturer's product data indicating compression strength of concrete supports and material used for tie wires.
 - 2) Wire chairs and slab bolsters: Manufacturer's product data.
 4. Concrete materials:
 - a. Cement:
 - 1) Mill certificate in accordance with ASTM C150. Include "Type" and results of testing for alkali content measured as equivalent alkalies.
 - b. Supplementary cementitious materials:
 - 1) Fly Ash: Identify source and provide testing results documenting compliance with ASTM C618 and any additional requirements of this Section.
 - c. Aggregates:
 - 1) Type, pit or quarry location, and producer's name.
 - 2) Commercial laboratory test reports for samples of each aggregate proposed for use. Tests shall have been made not more than 24 months prior to the date of the submittal.
 - a) Fine aggregate: Gradation analysis, specific gravity, reactivity, and reports of deleterious materials to document compliance with ASTM C33.
 - b) Coarse aggregate: Gradation analysis, specific gravity, soundness, reactivity, and reports of deleterious materials to document compliance with ASTM C33 for each size used.
 - d. Admixtures:
 - 1) Manufacturer's catalog cuts and product data indicating compliance with the standards specified.
 5. Concrete mixes: Submit full details, including:
 - a. Mix proportions measured by both weight and volume and concrete properties for each class of concrete proposed for use.
 - 1) Information on correction of batching for varying moisture contents of fine aggregate.
 - b. Data to establish the average compressive strength:
 - 1) If established by field test records, submit:
 - a) Product and test data for the materials actually used in the mix.
 - b) Actual mix proportions used in the mix producing the record.

- c) Field test data for slump, air content, and 28-day compressive strength. Include not less than 15 tests in accordance with ACI 318 Chapter 5.
 - 2) If established by testing of trial batches, submit:
 - a) Confirmation that the materials and proportions used in the trial batches are those that will be provided for the mix.
 - b) Mix test data for slump, air content, and 28-day compressive strength.
 - 3) For either method, include calculations for:
 - a) Standard deviation: Calculated in accordance with ACI 318 requirements.
 - b) Required average compression strength (f'_{cr}) using the standard deviation calculated in accordance with ACI 318 requirements.
 - c) Statement demonstrating that the average compression strength from field test records or from trial batch testing for each mix ($f'_{c_{avg}}$) exceeds the required average compressive strength (f'_{cr}) for that mix.
- c. Data to establish alkali load:
 - 1) Determine and include the alkali load of the proposed mix.
- d. Data to establish chloride content:
 - 1) Submit test results showing that the concrete mix contains water-soluble chloride ion content contributed from the constituents including water, aggregates, cementitious materials, and admixtures is less than the limit specified in Table B of this Section. Test shall be performed in accordance with ASTM C1218 at age between 28 and 42 days after mixing.
- 6. Concrete finishing and curing materials:
 - a. Manufacturer's name and product data sheets.
- C. Shop drawings:
 - 1. Reinforcement:
 - a. Submit drawings showing bending and placement of reinforcement.
 - 1) Drawings shall be in accordance with ACI SP-66.
 - 2) Clearly show placement, shapes, and dimensions of each bar listed in the bill of materials, including additional reinforcement at corners and openings required by details in the Contract Documents.
 - 3) Show splice locations and bar lengths reflecting Contractor's intended placement sequence.
- D. Samples:
 - 1. Form ties: If requested by the Engineer.
 - 2. Concrete bar supports: If requested by the Engineer, provide samples of:
 - a. Precast concrete bar supports ("dobies").
 - b. Wire chairs and slab bolsters.
- E. Procedures:
 - 1. Contractor's plans for production, placement, finishing, curing, protection, and temperature monitoring of concrete during the following environmental conditions:
 - a. Hot weather.

- F. Project record documents:
1. For the following items, note location of concrete in the structure, and include tag numbers of associated cylinders for compression strength tests.
 2. Concrete delivery tickets. Submit copies of concrete delivery tickets within 24-hours after delivery.
 3. Field test reports: Results of field-testing for slump, temperature, unit weight, and air entrainment.
 4. Testing laboratory reports for compression strength.
- G. Notifications:
1. Modifications to concrete mixes:
 - a. Submit notification of any adjustments to mixture proportions and any changes in materials made during the course of the Work for Engineer's review.
 - b. Include details of the changes and supporting documentation.
 2. Joint locations:
 - a. Where joint locations other than those indicated on the Drawings are requested, submit proposed locations for Engineer's review.
 - b. Provide drawings showing proposed joint locations with joint types labeled and joint details referenced.
 3. Reinforcement placement: Where necessary to move reinforcement beyond the specified placing tolerances to avoid interference, submit the proposed arrangement for Engineer's review.
 4. Concrete placements: Submit notification of readiness for each concrete placement at least 24 hours in advance.
 5. Concrete repairs:
 - a. Where concrete surfaces or sections exhibit defects after removal of forms, submit description of existing conditions and of proposed repair procedures and materials.
 - b. Include photos of existing conditions with submittal.

1.05 QUALITY ASSURANCE

- A. Tolerances on concrete construction: In accordance with ACI 117 unless more stringent requirements are specified in the Contract Documents.
- B. Concrete mixtures:
1. Ensure that concrete produced has the specified characteristics in the freshly mixed state, and that those are maintained to during transport and delivery and to the point of final placement.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle concrete materials in manner as to prevent damage and inclusion of foreign substances.
- B. Deliver reinforcing steel bundled and tagged with identifying tags marked in a legible manner with waterproof markings showing the same designations as indicated on the submitted shop drawings.
1. Store off the ground and protect from moisture, dirt, oil, and other injurious contaminants.

- C. Protect concrete accessories from weather and direct exposure to sunlight before installation.

1.07 PROJECT CONDITIONS

- A. Environmental requirements:
 - 1. Hot weather concreting: Construct in accordance with ACI 305 during conditions when the ambient air temperature is above 90 degrees Fahrenheit.
 - 2. Conditions that promote rapid drying of freshly placed concrete, such as low humidity, high temperature, and wind: Take corrective action to minimize loss of water from the concrete.

1.08 SEQUENCING AND SCHEDULING

- A. Schedule placing of concrete in such a manner that completes any single placing operation to a construction, or expansion joint as indicated on the Drawings or accepted by the Engineer in advance of the placement.

PART 2 PRODUCTS

2.01 FORMWORK

- A. Forms:
 - 1. Design and performance requirements:
 - a. Design and performance of formwork shall be the responsibility of the Contractor, subject to the requirements of the Contract Documents.
 - b. Design, construct, and brace formwork to:
 - 1) Carry all loads applied or transmitted, including the pressure resulting from placement and vibration of plastic concrete.
 - 2) Remain tight to prevent loss of mortar.
 - 3) Maintain specified tolerances and provide finished surfaces as specified.
 - c. Maximum deflection of facing materials and supporting members on surfaces exposed to view in the finished work: 0.0042 times the clear span ($\text{span}/240$).
 - d. Maximum deviation from alignment (horizontal or vertical): In accordance with ACI 117.
 - 2. Form facing materials:
 - a. Surfaces exposed to view in the finished work:
 - 1) Facing materials shall produce a smooth, uniform texture on the concrete.
 - 2) Do not use materials with raised grain, tears, worn edges, patches, dents, or other similar defects.
 - 3) Acceptable materials: Plywood with "C" or better face; plastic-faced plywood; tempered concrete form grade hardboard; or steel.
 - b. Surfaces not exposed to view in the finished work:
 - 1) Special form facing material not required.
 - 3. Forms for chamfers and keyways:
 - a. Uniform steel, plastic, or lumber section of dimensions shown or specified.

- b. Provide adequate stiffness and support to maintain a true line at the concrete surface.
 - c. Treated to eliminate bond with the concrete if required to produce a smooth, uniform, and undamaged finish upon removal.
- B. Form ties:
 - 1. General:
 - a. Provide form ties fabricated by recognized manufacturer of concrete forming equipment and suitable for use with the forming system selected.
 - b. Provide ties that accurately tie, lock, and spread forms:
 - 1) Do not use wire ties or wood spreaders.
 - c. Provide form ties manufactured such that, when forms are removed, the tie leaves no metal or other material within 1-1/2 inches of the surface of the concrete.
 - d. Do not allow tie holes through forms for ties to leak during concrete placement.
 - 2. Cone snap ties: Tie with removable plastic cone leaving a tapered depression having a minimum diameter of 1 inch at the surface of the concrete and a depth of 1-1/2 inches below the surface.
- C. Dry-pack mortar for filling cone snap tie holes:
 - 1. Proportioned mix of 1 part of portland cement to 1 part plaster sand with potable water added to provide a stiff consistency that can be driven into holes and properly compacted.
 - 2. Admixtures or additives to mortar are not permitted.
- D. Form release agent: Commercially manufactured, non-staining formwork release agent that will prevent absorption of water by the formwork and will prevent bond between the formwork and the concrete.
 - 1. Form release agent to comply with all local air quality management regulations.

2.02 JOINT MATERIALS

- A. Synthetic sponge rubber expansion joint material:
 - 1. Elastic sponge rubber compound in accordance with ASTM D1752, Type I.
 - 2. Concrete-gray color unless otherwise noted.
 - 3. Thickness: As indicated on the Drawings.
 - 4. Manufacturers: One of the following or equal:
 - a. Williams Products Inc., Everlastic 1300.
 - b. WR Meadows, Seal Tight Sponge Rubber Expansion Joint.
- B. Bituminous fiber expansion joint material:
 - 1. Thickness: To match joint width indicated on the Drawings.
 - 2. Asphalt-impregnated fiberboard in accordance with ASTM D1751.
 - a. Manufacturers: One of the following or equal:
 - 1) Durajoint.
 - 2) W.R. Meadows, SealTight Fibre Expansion Joint.
- C. Sealants and caulking: As specified in Section 07_92_00 - Joint Sealants.

- D. Waterstops:
 - 1. Hydrophilic rubber waterstops: As specified in Section 03_15_14 - Hydrophilic Rubber Waterstop.

2.03 REINFORCEMENT

- A. Materials:
 - 1. Deformed bars: In accordance with ASTM A615 Grade 60.
 - 2. Welded wire fabric: Sheets of plain wire in accordance with ASTM A185.
 - 3. Bar supports:
 - a. Over ground or "mud mat":
 - 1) Precast concrete blocks with cast-in annealed steel tie wires, 16 gauge or heavier.
 - a) Compressive strength of blocks equal to or exceeding the compressive strength of the surrounding concrete.
 - 2) Height as required for minimum 3 inches of clear concrete cover below reinforcement.
 - 3) Minimum block "footprint" of 4 square inches, or as required to supporting load from reinforcement while maintaining the required concrete cover.
 - b. Wire supports: Class 2, Type B stainless steel protected wire in accordance with CRSI Manual of Standard Practice.
 - 4. Tie wire: Annealed steel.
- B. Fabrication:
 - 1. Cut and cold-bend bars in accordance with provisions of ACI 315 and ACI 318.
 - 2. Fabricate reinforcement to the tolerances in accordance with ACI 117.
 - 3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.

2.04 SOURCE QUALITY CONTROL

- A. Submit documentation that the proposed concrete mixes will conform to the requirements of this Section and will produce concrete having the required proportions and properties specified.
 - 1. Do not place concrete until the design for that mix and the results of any trial batch testing have been accepted by the Engineer.
 - 2. If the Engineer requires changes to the mix design, modify mixes within limits set forth in this Section and submit new mix design for Engineer's review.
- B. After acceptance, do not change mixes or mix proportions without prior acceptance by the Engineer.
 - 1. Exception: At all times, adjust batching of water to compensate for free moisture content of aggregates. Total water content in the mix shall not exceed that specified.
- C. If there is change in source of cement or aggregate, or if there is a significant change in the characteristics or quality of any constituent material received from a source accepted to supply materials, submit new design mixes for each class of concrete affected.

- D. Testing of materials and mixes before placement to demonstrate that they comply with the requirements of this Section shall be at the Contractor's expense.

2.05 CONCRETE MIXES

A. Constituent materials:

1. Cement:
 - a. Portland cement: In accordance with ASTM C150, Type II or Type III:
 - 1) Cement for finishes or repairs: Provide cement from same source and of same type as concrete to be finished.
2. Supplementary Cementitious Materials (SCM):
 - a. Fly ash:
 - 1) In accordance with ASTM C618, Class F.
 - 2) Sampling and testing: In accordance with ASTM C311.
 - 3) Loss on ignition: Not to exceed 4 percent.
3. Aggregates:
 - a. General:
 - 1) Provide normal weight concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of the amounts specified.
 - 2) Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, or other construction waste.
 - 3) Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operations.
 - 4) Alkali-silica reactivity:
 - a) Provide fine and coarse aggregate classified as aggregate-reactivity class of R0 in accordance with ASTM C1778 and with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260 and not greater than 0.04 percent at 1 year when tested in accordance with ASTM C1293.
 - b) Aggregates classified as potentially reactive based on the preceding tests may be permitted, at the discretion of the Engineer, if the following condition is satisfied:
 - (1) Testing with the reactive aggregate, cement, and supplemental cementitious materials in accordance with ASTM C1567 demonstrates that expansion is less than 0.10 percent at 14 days.
 - b. Fine aggregate:
 - 1) Provide fine aggregate consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
 - 2) In accordance with ASTM C33.
 - c. Coarse aggregate:
 - 1) Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances; and in accordance with ASTM C33, Class 4S.

- 2) Grading: Unless otherwise specified or accepted in writing by the Engineer, provide the following:
 - a) Aggregate for Class A, C, and PM Concrete: ASTM C33, Size Number 57.
 - b) Aggregate for Class CE Concrete: ASTM C33, Size Number 8.
 - c) Where a combination of 2 or more sizes of coarse aggregate are used, the gradation of the blend shall conform to the grading requirements in accordance with ASTM C33 for the size number specified.
4. Water:
 - a. Water for concrete mixes, for washing aggregate, and for curing concrete: Potable water, clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
 - b. Do not exceed the optional chemical limits of ASTM C1602.
5. Admixtures:
 - a. General:
 - 1) Do not use admixtures, except those specified, unless written authorization has been obtained from the Engineer.
 - 2) Admixtures shall be compatible with concrete and other admixtures. Admixtures (other than fly ash) shall be the products of a single manufacturer to ensure compatibility.
 - 3) Do not use admixtures containing chlorides in excess of 0.5 percent by weight of cement when calculated as chloride ion.
 - b. Air entraining admixture: In accordance with ASTM C260.
 - c. Water reducing admixture:
 - 1) In accordance with ASTM C494, Type A or Type D.
 - 2) Not containing air-entraining agents.
 - d. High range water reducing admixtures/plasticizing admixtures:
 - 1) High-range water reducing admixtures: In accordance with ASTM C494, Type F.
 - 2) Plasticizing admixtures: In accordance with ASTM C1017, Type I.
 - 3) Use shall produce non-segregating concrete mixture with little bleeding that remains in a plastic state for not less than 2 hours.
 - e. Coloring admixture:
 - 1) To produce red-colored concrete for encasement of electrical ducts, conduits, and similar items:
 - a) Mix 10 pounds of coloring agent into each cubic yard of concrete, unless otherwise recommended by the manufacturer and accepted by the Engineer.
 - 2) Manufacturers: One of the following or equal:
 - a) Davis Colors, #100 Utility Red.
 - b) I. Reiss Co., Inc., equivalent product.
 - c) Euclid Chemical Co., Increte Division, "Colorcrete Brick Red."
- B. Mix design and proportioning:
 1. Proportion mixes to provide compression strength, workability, and durability as specified in this Section.
 2. Submit documentation that the proposed mixes will conform to the requirements of this Section and will produce concrete having the required properties.

3. Compression strength:
 - a. Proportion each concrete mix to provide the required average compressive strength (f'_{cr}) determined in accordance with the provisions of ACI 318 Chapter 19.
 - b. Determine required average compressive strength (f'_{cr}) for each class of concrete using the specified compressive strength of the mix, f'_c , and the standard deviation determined in accordance with ACI 318.
 - 1) Establish the standard deviation in accordance with ACI 318 and based on either field test records or based on trial batches.
 - 2) Documentation of standard deviation based on field test records:
 - a) Calculate standard deviation in accordance with ACI 318 procedures using test records that:
 - (1) Represent materials, quality control procedures, and conditions similar to those expected for this Work.
 - (2) Do not include provisions for materials and proportions that are more restrictive than the materials proposed for use in this Work.
 - (3) Represent a mix proportioned to provide a specified compressive strength (f'_c) within 1,000 pounds per square inch of that specified for the corresponding mix in this Section.
 - 3) Documentation of standard deviation based on trial batches plus empirical code requirements:
 - a) When records including at least 15 consecutive tests that span a period of at least 45 calendar days are not available, determine required average compressive strength (f'_{cr}) from Table A:

TABLE A Required Average Compressive Strength	
Specified Compressive Strength f'_c (pounds per square inch)	Required Average Compressive Strength f'_{cr} (pounds per square inch)
Less than 3,000	$f'_c + 1,000$
3,000 to 5,000	$f'_c + 1,200$

4. Workability:
 - a. Provide concrete with workability and consistency that can be readily worked into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on the surface.
5. Cement content:
 - a. Minimum cementitious materials content: Conform to values specified in Table B of this Section.
 - b. Ratio of water to cementitious materials:
 - 1) Conform to values specified in Table B of this Section.
 - 2) Total water, including that from moisture content of aggregates and admixtures, shall not exceed that specified in Table B of this Section.

6. Supplementary Cementitious Materials:
 - a. Fly ash:
 - 1) Maximum of 20 percent by weight of total weight of cementitious materials (cement plus fly ash).
 - 2) Other supplemental cementitious materials shall not be used without prior acceptance by the Engineer.
7. Aggregates:
 - a. Ratio of coarse aggregate to fine aggregate: Not less than 1.0 or more than 2.0 for all concrete classes, with exception of Class CE.
8. Admixtures:
 - a. Use in accordance with manufacturer's instructions.
 - b. Air entraining admixture:
 - 1) Not required.
 - c. Water reducing admixture:
 - 1) No decrease in cementitious materials content is permitted as a result of use of water reducing admixture.
 - d. High range water reducing admixture/plasticizing admixture:
 - 1) Proportion for a slump of 2 to 4 inches before the admixture is added, and a maximum slump of 8 inches after the admixture is added.
 - e. Coloring admixture:
 - 1) Unless otherwise recommended by the manufacturer, mix into each cubic yard of concrete 10 pounds of coloring agent.
9. Concrete mix design requirements by class:
 - a. Provide concrete mixes for each "class" specified in this Section and indicated in Table B of this Section.
 - b. Use each class at the locations specified in the following paragraphs or indicated on the Drawings.
 - 1) "Class A" Concrete: General use. Use at all locations unless otherwise indicated on the Drawings or listed in the following paragraphs.
 - 2) "Class C" Concrete: May be used as fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and elsewhere as indicated on the Drawings.
 - 3) Class CE Concrete: Use for electrical conduit and duct bank encasements.
 - 4) Class PM concrete: Use for concrete pavement, cart paths, curbs, gutters, and sidewalks.
 - c. Pumped concrete: Provide a separate mix design and substantiation testing for each "class" to be placed by pumping.

TABLE B Concrete Classes									
Concrete Class	Minimum Specified Compressive Strength at 28 days, f' _c ⁽¹⁾ (pounds per square inch)	Ratio of water to cementitious materials ^(2,3) (minimum - maximum).	Cementitious Materials Content ⁽³⁾ (pounds per cubic yard of concrete by weight)	Cement Type (ASTM C150)	Maximum Chloride Content (percent by weight of cement)	Maximum Coarse Aggregate Size ⁽⁴⁾	Air Entrainment (percent) (N/R: not required.)	Admixtures required ⁽⁵⁾	Slump Range (inches)
A	4,500	0.40 to 0.45	535 to 575II	II	0.15	57	N/R	WRA	2 to 4
C	2,500	0.62 max.	Minimum 423	II	No limit	57	N/R	WRA	3 to 6
CE	2,500	0.62 max.	Minimum 423	II	No limit	8	N/R	WRA CA	3 to 6
PM	2,500	0.40	535 to 575	II	0.15	57	N/R	WRA	3 to 6
Notes: 1 At locations where concrete will not be subjected to load from other elements of the structure or from Contractor's placing operations, maximum time period for achievement of specified compressive strength may be extended to 56 days when accepted by the Contractor's Engineer. 2 W/C Ratio = Ratio of water to cementitious materials (portland cement plus supplemental cementitious material) by weight Include weight of admixtures in the water content of the mix when the quantity of the admixtures exceeds 10 ounces per 100 pounds of cement. 3 Provide mix within the range of W/C ratio and cementitious materials content indicated. 4 Size number in ASTM C33, Table 2 5 Admixtures are designated as follows: AEA: Air entraining admixture. CA: Coloring Admixture. HRWR: High-range water reducing admixture. WRA: Water reducing admixture.									

2.06 CONCRETE BATCHING AND MIXING EQUIPMENT

- A. Provide equipment and facilities for accurate measurement and control of materials.
 - 1. At all times, maintain proportions of concrete mix within specified limits.
 - 2. Control and adjust batch weights to secure maximum yield.
- B. Measuring or weighing equipment:
 - 1. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
 - 2. Devices shall bear the current and valid seal of the Sealer of Weights and Measures in the Authority having jurisdiction.
 - 3. Furnish devices capable of providing successive quantities of individual materials measured to within 2 percent of desired amount of that material.
- C. Mixing equipment:
 - 1. Mixes shall be ready-mix or transit-mixed concrete in accordance with ASTM C94.
 - a. Hand-measured or hand-mixed batches shall not be used.
 - 2. Provide equipment capable of combining aggregates, cementitious materials, water, and admixtures into a thoroughly mixed and uniform mass during the time periods specified, and capable of discharging the resulting mixture without segregation.
 - 3. Maintain mixing equipment in good working order. Operate at loads and speeds, and for periods of time recommended by the manufacturer or specified in this Section.

2.07 CONCRETE FINISHING AND CURING MATERIALS

- A. Evaporation retardant:
 - 1. Manufacturers: One of the following or equal:
 - a. Master Builders Solutions, MasterKure ER 50.
 - b. Euclid Chemical Co., Eucobar.
- B. Plastic membrane for curing:
 - 1. White polyethylene film in accordance with ASTM C171:
 - a. Nominal thickness not less than 0.0040 inches when measured in accordance with ASTM D2103, and thickness at any point not less than 0.0030 inches.
 - b. Loss of moisture: Not to exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.
- C. Sprayed membrane curing compound:
 - 1. In accordance with ASTM C309, Type 1D. Clear with fugitive dye.

PART 3 EXECUTION

3.01 GENERAL

- A. Preparation:
 - 1. Use construction methods and sequences that allow time for concrete to reach adequate strength to prevent damage to or overstress of the concrete structure or its elements during construction.
 - 2. Locations of construction and expansion joints are indicated on the Drawings.
 - a. Make no other joints, except as accepted in advance by the Engineer.
 - b. Schedule placing of concrete to complete any single placing operation between designated joints.
 - c. Schedule and sequence placements to allow adequate time for concrete to achieve adequate strength before subsequent placements and loads are applied to the structure.
- B. Verification of conditions:
 - 1. Do not place concrete until:
 - a. Forms have been thoroughly cleaned of dirt and debris, and form release agents have been applied.
 - b. Forms have been thoroughly checked for alignment, level, strength, and accurate location of reinforcement, joint accessories, and mechanical and electrical inserts or other embedded items.
 - c. Reinforcement is secure and properly fastened in its correct position.
 - d. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
 - e. Forms are aligned and secured, and loose form ties at construction joints have been retightened.
 - 2. Notify the Engineer in writing of readiness, not just intention, to place concrete in any portion of the work:
 - a. Provide this notification in advance of operations, allowing such time as the Engineer deems necessary to make final observation of preparations at location of the concrete placement.
 - b. Have forms, reinforcement, screeds, anchors, ties, embeds, and inserts in place before notifying Engineer of readiness for final observations.
 - 3. Do not place concrete until Engineer has completed final observations of conditions at the placement and has given acceptance to proceed.

3.02 FORMING

- A. General:
 - 1. Do not use earth cuts as forms for vertical or sloped surfaces unless specifically required by or indicated on the Contract Documents.
 - 2. Joints: Locate joints as indicated on the Drawings:
 - a. Submit joint locations other than or differing from those indicated on the Drawings for Engineer's review before construction.
 - 3. Chamfers:
 - a. Permanently exposed outside corners: Provide 3/4-inch chamfer.
 - b. Re-entrant corners:
 - 1) Chamfer not required.

- 2) Corner may be left square.
 - c. Edges of formed joints: Chamfer not required except where indicated on the Drawings.
 - 4. Level strips: Install level strips at top of wall concrete placements to maintain true line at horizontal construction joints.
- B. Constructing and erecting formwork:
- 1. Brace and anchor formwork to ensure vertical and lateral stability and to maintain finish tolerances when subjected to uplift pressures and lateral pressures from plastic concrete.
 - a. Ensure that formwork is positioned, braced, and firmly held against previously placed concrete to maintain flush surfaces and to prevent loss or leaking of mortar at construction joints.
 - 1) At joints with flush surfaces exposed to view, lap contact surface of form a maximum of 1-inch over the previously placed concrete.
 - b. Design and construct forms with sufficient strength and stiffness that deflections resulting from loading by plastic concrete will not exceed the surface tolerance limits specified.
 - c. Set forming materials in an orderly and symmetrical arrangement, keeping the number of seams to a practical minimum.
 - d. Form ties: Tie forms together using cone snap ties placed at not more than 2-foot centers vertically and horizontally.
 - e. Construct formwork to permit easy removal without damage to formed surfaces.
 - f. Provide temporary openings at the base of column and wall formwork to allow cleaning and inspection immediately before concrete placement.
 - g. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.
 - 2. Where forms are re-used, clean surfaces of mortar, grout, and foreign materials before coating with form release agent and setting.
 - 3. Cover formwork surfaces with form release agent to prevent bond with the concrete:
 - a. Do not allow form release agent to puddle in the forms.
 - b. Do not allow form release agent to contact reinforcement, embeds, or previously placed concrete.
 - 4. Provide runways supported directly on the formwork for moving equipment and supplies during preparations for concreting:
 - a. Do not rest such runways on reinforcement.
- C. Embeds, joints, and accessories:
- 1. Position pipes, sleeves, conduits, inserts, anchors, castings, and other embedded items in the forms, and anchor to formwork to prevent displacement.
 - 2. Fill voids in sleeves, pipes, inserts and anchor slots with readily removable material, and seal if required to prevent entry of mortar.
 - 3. For pipe or conduit runs, position embeds to allow at least 3 inches of clear concrete separation between parallel runs of pipes, conduits or any combination of these items with each other or with reinforcement.

- D. Removing formwork:
1. Remove forms after the specified time for curing and protection has been provided and when operations will not damage concrete.
 2. Immediately after forms are removed, carefully examine concrete surfaces.
 - a. Report any irregularities in surfaces and finishes to the Engineer.
 - b. Where surface repairs are needed, contact Engineer with description of conditions and description of repair procedures before proceeding with work.
 3. Immediately follow form removal with installation of specified curing materials and procedures.
 4. After forms are removed from wall and curing is complete, fill tie holes as follows:
 - a. Remove form ties and cones from surfaces.
 - b. Roughen cone-shaped tie holes by heavy sandblasting before repair.
 - c. Clean and dampen tie holes, maintaining a saturated surface for at least 2 hours before applying dry-pack mortar.
 - d. Dry pack cone-shaped tie holes with dry-pack mortar as specified in this Section.

3.03 PLACING CONCRETE REINFORCEMENT, EMBEDS, AND ACCESSORIES

- A. Preparation:
1. Cut and bend deformed steel reinforcement in the shop and deliver completed bars to the site for installation.
 - a. Do not field-bend deformed reinforcement.
 2. Surface preparation:
 - a. Thoroughly clean reinforcing bars from rust scale, loose mill scale, rust coat, dirt, oil, and other coatings that adversely affect bonding capacity when placed in the work.
 - 1) Thin coating of red rust resulting from short exposures will not be considered objectionable.
 - b. Remove concrete or other deleterious coatings on dowels and other reinforcement projecting from previous placements by wire brushing or sandblasting before the reinforcement is embedded in the subsequent placement.
- B. Support of reinforcement and accessories:
1. Provide supports for deformed bars and wire fabric to maintain reinforcement position indicated on the Drawings and to provide specified minimum clear concrete cover around the reinforcement.
 2. Use number of supports required to prevent reinforcement from sagging and to support loads during construction, but in no fewer quantities and locations than recommended by ACI SP-66 and CRSI Manual of Standard Practice.
 3. Support wire fabric from reinforcing supports:

Do not place wire fabric on grade or forms for subsequent lifting into plastic concrete during the concrete placement.

 - a. Take care to maintain specified position of wire fabric in the concrete section and to prevent bending, draping, or kinking of the wires.

4. Do not:
 - a. Use brick, broken concrete masonry units, concrete spalls, rocks, or other such material for supporting reinforcement.
 - b. Support reinforcement on additional reinforcing bars installed with less cover than that required by the Contract Documents ("give away bars").
 - c. Adjust location of reinforcement indicated on the Drawings to increase cover over support bars.
 5. Furnish and use templates for placing column dowels.
- C. Placing reinforcement:
1. Locate reinforcement to provide minimum clear concrete cover specified:
 - a. Where cover is not specified, provide cover in accordance with ACI 318.
 2. Accurately place reinforcement in accordance with the tolerances of ACI 117:
 - a. Where reinforcement must be moved beyond the specified placing tolerances to avoid interference with other reinforcement, conduits, or embeds, submit the proposed arrangement for Engineer's review.
 3. Fasten reinforcement securely in place with wire ties:
 - a. After tying, bend ends of wire ties inward towards the center of the concrete to match clear concrete cover provided for reinforcement.
 4. Do not weld reinforcing bars or wires.
 5. Deformed reinforcing bars:
 - a. Tie slab bars at every intersection around the perimeter of slabs.
 - b. Tie wall bar and slab bar intersections, other than those around the perimeter, at every 4th intersection, but not more than 48 inches on center each way.
 - c. Lap splices:
 - 1) Lap reinforcement at splices as indicated on the Drawings or specified.
 - 2) Unless indicated on the Drawings, install lap splices with bars in contact and fastened together with tie wire.
 - 3) If lap splice length is not indicated on the Drawings, provide lap splice equal to 40 times reinforcing bar diameter.
 6. Welded wire fabric reinforcement:
 - a. Bend fabric as indicated on the Drawings or required to fit work.
 - b. Straighten fabric to make reinforcement in each face a flat, planar surface before placing in the Work.
 - c. Extend welded wire fabric across concrete section to provide fabric to within 2 inches of vertical concrete edges.
 - d. Lap splice welded wire fabric as indicated on the Drawings:
 - 1) If no splice details are indicated, lap fabric at least 12 inches, fasten with wire ties spaced not more than 24 inches on center, and lace lap with wire of the same diameter of the fabric.

3.04 BATCHING, MIXING, TRANSPORTING AND DELIVERING CONCRETE

- A. General:
1. Measure, batch, mix, transport, and deliver ready-mixed concrete in accordance with ASTM C94.

- B. Measuring and batching:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
 - a. Weigh cementitious materials separately.
 2. Furnish satisfactory means for checking moisture content of aggregates before batching.
 - a. Adjust mix water to compensate for free moisture content of aggregate.
 3. Mixing water:
 - a. Measure by volume or by weight.
 - b. Maximum water-to-cementitious materials ratio for each concrete class shall not exceed that specified in Table B of this Section.
 4. Admixtures:
 - a. Provide admixtures as specified.
 - b. Batch products by means of mechanical batcher capable of accurate measurement, and in accordance with the admixture manufacturer's instructions.
- C. Mixing and transporting:
1. Mixing:
 - a. Equip each truck mixer with device capable of counting number of drum revolutions and interlocked to prevent discharge of concrete from drum before required number of revolutions is complete.
 - b. Once drum revolutions commence, continuously revolve drum until it has completely discharged its batch.
 - c. Do not add water until drum commences revolutions.
 - d. Engineer may require an increase in the designated minimum number of revolutions, or a decrease in the designated maximum number of revolutions if necessary to obtain satisfactory mixing.
 - 1) Incorporate such changes without additional costs to Owner.
 2. Do not exceed the following time period for mixing and delivery:
 - a. Total elapsed time from addition of water at batch plant through discharging of mix: Not to exceed the lesser of 90 minutes nor 300 revolutions of the mixer drum.
 - b. Total elapsed time for from arrival at the project site to completing discharge of mix: Not to exceed 30 minutes.
 - c. Under conditions contributing to quick setting, the Engineer may reduce total elapsed time permitted.
- D. On-site acceptance of concrete mixes:
1. Concrete shall possess the properties specified in this Section at the point of placement.
 2. Do not place concrete:
 - a. Having slump outside the limits indicated in Table B of this Section.
 - b. That does not conform to specifications for entrained air content.
 - c. For which the total elapsed time of mixing or elapsed time at the site exceeds the specified maximums.

3.05 CONVEYING, DEPOSITING, AND CONSOLIDATING CONCRETE

A. Preparation:

1. General:

- a. Clean construction joints and forming surfaces of dirt, sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
 - 1) Use vacuum cleaner if required to provide clean surfaces.
- b. Remove snow, ice, frost, and standing water from surfaces of formwork, reinforcement, and embeds in contact with concrete.
- c. Secure reinforcement, joint materials, anchors, embeds and other items in place.
- d. During conveying, placement, consolidation, and finishing of concrete, protect surrounding construction, including concrete walls and slab surfaces, from concrete splatter.
- e. Thoroughly clean surrounding construction at the completion of each placement and before splatter sets up.

2. Concrete construction on grade:

- a. Provide subgrade preparation, base materials, and compaction as required by the Contract Documents.
- b. Remove loose soils, debris, standing water, snow, or ice from subgrade.
- c. Provide moist subgrade with no standing or free water and no muddy or soft spots.
 - 1) When subgrade is not moist, sprinkle with water not less than 2 nor more than 6 hours in advance of placing concrete.
 - 2) If subgrade becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.

3. Weather conditions:

- a. Hot weather: In hot weather conditions, make provisions in advance of placement for windbreaks, shading, fogging, sprinkling, ponding, or wet covering.
- b. Cold weather: In cold weather conditions, make provisions to maintain the required concrete temperatures without overheating or drying, and without exposing concrete to carbon dioxide from heater exhaust.
- c. Precipitation:
 - 1) Do not begin placements while rain, sleet, or snow is falling or anticipated, or unless adequate protection is provided.
 - 2) Do not allow precipitation to increase concrete water content or to damage the surface of the concrete.
- d. Wind:
 - 1) Do not begin placements during wind events that will blow dust or debris into the plastic concrete.
 - 2) Do not allow wind-blown debris to become embedded in or to damage the surface of the concrete.
 - 3) At all times, have sufficient coverings on hand to protect new concrete from excessive drying or blowing debris.

B. Conveying concrete:

1. Convey concrete from mixer to place of final deposit by methods that prevent segregation or loss of materials.

2. Use chutes, pumps, and conveyors of size and design that will ensure continuous flow of concrete at point of delivery without cold joints.
 3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from the chute or conveying device.
 4. Keep conveying equipment clean by thoroughly washing and scraping upon completion of any placement.
- C. Depositing concrete:
1. Do not place concrete under the following conditions:
 - a. After initial set has occurred.
 - b. When re-tempering has occurred.
 2. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
 - a. Do not use vibrators to move concrete from its point of deposit.
 - b. Use tremies for placing concrete where drop is over 5 feet.
 3. Place concrete continuously in approximately horizontal layers not exceeding 24 inches in depth. Bring level up evenly in all parts of forms.
 - a. After placement begins, continue without significant interruption and as a continuous operation until the end of that placement is reached.
 - b. Do not allow "cold joints" to form between adjacent layers or areas of the placement, or initial set to form on "wet edge" of placements.
 - c. Take precautions to prevent delays between placement of adjacent layers or areas from exceeding 20 minutes.
 - 1) If more than 20 minutes elapse after the initial surface was placed, spread a layer of neat cement grout, as specified for construction joints before depositing additional concrete.
 4. Placing concrete on slopes: Commence placement at bottom of slope and work upward.
 5. Placing horizontal concrete monolithically with structures below:
 - a. If concrete for slabs, beams, or walkways is to be cast monolithically with walls or columns below, do not place the horizontal concrete elements until the concrete in walls or columns below has been placed, consolidated, and allowed to achieve initial set.
 - b. Allow set time of not less than 1 hour.
 - c. Maintain a moist surface at the top of the walls or columns during the setting period.
 6. Placing a second concrete lift over hardened concrete below:
 - a. Take special precautions in form work at top of old lift and bottom of new lift to prevent:
 - 1) Spreading and vertical or horizontal displacement of forms.
 - 2) Grout "bleeding" onto finished concrete surfaces.
- D. Consolidating concrete:
1. Thoroughly consolidate concrete into forms and around reinforcement, pipes, and other embeds using mechanical vibrators.
 - a. Take special care to place concrete solidly against forms, leaving no voids.
 - b. Make concrete solid, dense, compact, and smooth.

2. Provide vibration energy sufficient to cause concrete to flow and readily settle into place, leaving no voids. Vibration should visibly affect concrete over a radius of at least 18 inches without segregation.
3. Vibrators:
 - a. At all times, have sufficient vibrators on hand to consolidate concrete as it is placed.
 - b. In addition to vibrators in use while concrete is being placed, have on hand at least 1 spare vibrator in serviceable condition.
 - c. Place no concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.

3.06 FINISHING CONCRETE

- A. Provide concrete finishes specified in Section 03_35_29 - Tooled Concrete Finishing.
- B. Liquid evaporation retardant:
 1. Apply evaporation retardant when environmental conditions will result in rapid evaporation of moisture from the surface of the fresh concrete during finishing operations. Such conditions include low humidity, high heat, and wind occurring alone or in combination.
 2. Immediately after the concrete is screeded, coat the surface of the concrete with a liquid evaporation retardant.
 3. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks and crazing at the surface.

3.07 CURING AND PROTECTING CONCRETE

- A. Curing concrete:
 1. Cure concrete by methods specified in this Section.
 2. Keep concrete continuously moist and at a temperature of at least 50 degrees Fahrenheit for at least 7 days after placement unless the details of a particular method specify a longer period.
 3. Make provisions to maintain moisture or curing membrane integrity at edges of slabs, tops of walls, and joint surfaces, and to prevent loss of protection.
 4. Schedule of curing methods:
 - a. Concrete surfaces that will receive additional materials that require bond to the initial placement (including concrete; concrete repairs, coatings, paints, sealers; grout, and other materials):
 - 1) Water curing or plastic membrane curing.
 - b. Formed surfaces:
 - 1) If non-absorbent forms are left in place for 7 days after placement: No additional requirements.
 - 2) For absorbent forms or when forms are removed during the 7 days following placement: Cure by water curing, plastic membrane curing, or sprayed membrane curing.
 - c. Unformed concrete surfaces:
 - 1) Water curing, plastic membrane curing, or sprayed membrane curing.

5. Water curing:
 - a. Keep surfaces of concrete constantly and visibly saturated by ponding, continuous fogging, or continuous sprinkling at all times during curing period.
 - 1) Cover surfaces if required to maintain saturated conditions.
 - 2) For horizontal surfaces, pond the surface with at least 2 inches of water or cover with saturated mats or fabric kept continuously wet.
 - b. Formed surfaces:
 - 1) Each day forms remain in place may be counted as 1 day of water curing.
 - 2) Do not loosen form ties while concrete is being cured by forms left in place.
 - 3) No further credit for curing time will be allowed after contact between the concrete surface and the forms has been broken.
6. Plastic membrane curing:
 - a. Cover concrete with plastic membrane, sealing joints and edges against displacement by wind or site operations and to prevent loss of moisture.
 - b. Install plastic membrane as soon as concrete is finished and can be walked on without damage.
 - c. Keep all surfaces of concrete under plastic membrane moist at all times during the curing period.
7. Sprayed membrane curing:
 - a. Application of curing compound:
 - 1) Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
 - a) If more than 1 hour elapses between removal of forms and application of curing compound, provide water curing of affected surfaces for the full curing period.
 - 2) Contractor is cautioned that the method of applying curing compound specified in this Section may require more compound than normally suggested by manufacturer of compound, and also more than is customary in the trade.
 - 3) Apply curing compound by mechanical, power-operated sprayer with mechanical agitator that will uniformly mix all pigment and compound.
 - 4) Apply compound in at least 2 coats, with each subsequent coat in a direction turned 90 degrees from the preceding coat.
 - 5) Apply curing compound in sufficient quantity that concrete has uniform appearance and that the natural color of the concrete is effectively and completely concealed immediately after spraying.
 - 6) Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
 - 7) Apply compound to a film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
 - 8) Take care to apply curing compound to edges of placements and over full surface profile of construction joints.
 - b. Removal of curing compound:
 - 1) Do not remove curing compound from concrete in less than 7 days after application.

- 2) Before placing fresh concrete against a surface previously coated with curing compound, remove the curing compound by heavy sandblasting, or alternate method acceptable to the Engineer.
 - 3) Prior to final acceptance of the work, remove any curing compound on surfaces exposed to view by sandblasting or other acceptable method. After removal, only the natural color of finished concrete shall remain visible, and such color shall be uniform over the entire surface.
- B. Protecting concrete:
1. Immediately after placement, protect concrete from hot or cold weather, and mechanical damage.
 2. Temperature:
 - a. Cold weather: Protect concrete during the curing period so that the concrete temperature is maintained within the following requirements.
 - 1) Sections less than 12 inches thick: Minimum 55 degrees Fahrenheit.
 - 2) Sections 12 to 36 inches thick: Minimum 50 degrees Fahrenheit.
 - b. Hot weather: Protect concrete during the curing period so that the concrete temperature does not exceed 90 degrees Fahrenheit.
 - c. Remove protection against temperature gradually so that concrete surface temperature does not drop or rise by more than 40 degrees Fahrenheit during any 24-hour period.
 3. Maintain forms, shoring, and bracing in place after concrete placement for a periods after concrete placement as indicated in the following paragraphs. Forms may be removed after these periods if the concrete has developed sufficient strength and hardness to resist surface or other damage.
 - a. Vertical forms:
 - 1) General: Minimum 24 hours after concrete placement.
 - 2) Sides of footings: Minimum 24 hours after concrete placement.
 - 3) Sides of beams, girders, and similar members: Minimum 48 hours after concrete placement.
 - b. Horizontal forms:
 - 1) Slabs, beams, and girders: Until concrete reaches specified compressive strength, $f'c$, or until shoring is installed.
 - c. Shoring for slabs, beams, and girders:
 - 1) Shore until concrete strength reaches specified compressive strength, $f'c$.
 - a) Temporary shoring may be required after the specified compressive strength is reached if construction loads will exceed the designated live load capacity of the structure.
 - d. Wall bracing:
 - 1) Brace until strength of concrete beams and slabs laterally supporting the wall reaches specified compressive strength, $f'c$.

- C. Loads against or on the concrete:
 - 1. Loading of green concrete, by backfilling or by placing personnel and equipment on the surface, is not permitted.
 - 2. Backfilling: Do not place backfill against concrete walls until the wall and all elements attached to it, including connecting slabs or beams, are fully braced by the structure, and have achieved their minimum specified compressive strength, f_c .

3.08 JOINTS AND JOINT PREPARATION

- A. Joint locations and details:
 - 1. Construct concrete work as monolith to the extent practical.
 - 2. Construct joints as indicated on the Drawings and as specified.
 - 3. Locations of construction, expansion, and other joints are indicated on the Drawings or specified in this Section.
 - a. Do not relocate, add, or delete joints without prior approval from the Engineer.
- B. Construction joints:
 - 1. Where spacing is not indicated on the Drawings, provide construction joints in slabs and walls at intervals not greater than 35 feet.
 - 2. Construct as indicated on the Drawings.
 - 3. Before placing fresh concrete against the joint: Use heavy sandblast to thoroughly clean joint surfaces and reinforcement crossing the joint of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter.
 - 4. Just before placing concrete against the joint, wash surface with water to saturate joint surface and concrete surfaces within 12-inches of the joint.
 - 5. Horizontal joints:
 - a. Immediately before placing concrete, thoroughly spread bed of neat cement grout over the joint surface. Grout shall be as follows:
 - 1) Use same sand-to-cementitious materials ratio that is used for concrete mix.
 - 2) Use same materials that are used for concrete.
 - 3) Use water-to-cementitious materials ratio that is no more than that specified for concrete.
 - b. Grout thickness: Not less than 1/2 inch, nor more than 1 inch.
- C. Expansion joints:
 - 1. Where width is not indicated on the Drawings, provide 3/4-inch wide joint.
 - 2. Construct as indicated on the Drawings.
 - 3. Do not extend reinforcement, conduits, or other items through expansion joints unless details for such crossings are indicated on the Drawings.
 - 4. Preformed expansion joint material:
 - a. Accurately position joint filler in the joint.
 - 1) Fasten to concrete or forms with adhesive.
 - 2) Fastening joint filler using nails, bolts, screws, or similar items is not permitted.
 - b. Tape splices in joint filler to prevent intrusion of mortar.

3.09 TOLERANCES

- A. Concrete:
 - 1. Finished concrete: Conform to shapes, lines, grades, and dimensions indicated on the Drawings.
 - 2. In accordance with ACI 117, except as modified in the following paragraphs:
 - a. Where more restrictive tolerances to accommodate equipment are indicated on the Drawings.
 - b. Slabs where slope is indicated:
 - 1) Uniformly slope to drain.
 - 2) Without depressions that puddle water.
 - c. Slabs indicated to be level:
 - 1) Maximum deviation of 1/8 inches in 10 feet without any apparent changes in grade.
 - 2) Without depressions that puddle water.
- B. Embeds:
 - 1. General:
 - a. Sleeves and inserts: Plus or minus 1/8 inch.
 - b. Projected ends of anchor bolts: Plus 1/4 inch; minus 0 inches.
 - c. Anchor bolt position: Plus or minus 1/16 inch.
 - 2. Equipment: Set inserts to tolerances required for proper installation and operation of equipment or systems to which insert pertains.

3.10 FIELD QUALITY CONTROL BY CONTRACTOR

- A. Provide quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.
- B. Field tests:
 - 1. During progress of construction, provide testing to determine whether the concrete, as being produced, complies with requirements specified.
 - 2. Sampling and testing shall be performed by Contractor's testing laboratory. Requirements as specified in Section 01_45_00 - Quality Control.
 - a. Cooperate in testing by allowing free access to the Work for testing laboratory to sample and test materials.
 - b. Provide full access for Engineer to observe concrete sampling and testing at any time.
 - c. Contractor is responsible for providing care of and curing conditions for test specimens in accordance with ASTM C31 until specimens are collected by testing laboratory.
 - d. Provide firmly braced, insulated, heated, closed wooden curing boxes. Include cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication through receipt at Contractor's testing laboratory.
 - 3. Testing shall include:
 - a. Sampling of concrete in accordance with ASTM C172.
 - b. Temperature of concrete at delivery in accordance with the requirements of ASTM C1064 and as specified in this Section.

- c. Slump of concrete using slump cone in accordance with the requirements of ASTM C143. Test slump at the following intervals:
 - 1) Test slump at the beginning of each placement.
 - 2) As often as necessary to keep slump within the specified range, but not less than every 6th truck.
 - 3) When requested to do so by the Engineer.
 - 4) Observe concrete during slump test for signs of segregation:
 - a) Observe concrete for mortar or moisture flow from slumped concrete.
 - b) Reject concrete if mortar or moisture flows out of the mix.
- d. Unit weight of concrete in accordance with ASTM C138.
- e. Air entrainment in accordance with ASTM C173. Test air content at the following intervals:
 - 1) At the beginning of each placement.
 - 2) As often as necessary to keep entrained air within the specified range, but not less than every 6th truck.
 - 3) When requested to do so by the Engineer.
- f. Compressive strength, f'_c , in accordance with ASTM C39. Required number of cylinders:
 - 1) Not less than 4 cylinder specimens, 4-inch diameter by 8-inches long, will be tested for each 150 cubic yards of each class of concrete; not less than 4 specimens for each half-day of placement.
 - 2) One cylinder will be broken at 7 days and 3 cylinders will be broken at 28 days.
- 4. Contractor shall:
 - a. Furnish concrete for test specimens and provide manual assistance to testing lab in preparing said specimens.
 - b. Assume responsibility for providing care and on-site curing and protection for test specimens in accordance with ASTM C31.

3.11 FIELD QUALITY CONTROL BY OWNER

- A. Provide on-site observation and field quality assurance for the Work of this Section as specified in Section 01_45_00 - Quality Control.
- B. Special tests and inspections: See Section 01_45_24 - Regulatory Quality Assurance.
- C. Field inspections:
 - 1. Required inspections:
 - a. Observe construction for conformance to the Contract Documents and the accepted submittals.
 - 2. Records of inspections:
 - a. Provide record of each inspection.
 - b. Submit copies to Contractor upon request.
- D. Field tests:
 - 1. Engineer may request, at any time, additional testing to confirm that materials being delivered and placed conform to the requirements of the Specifications.
 - a. If such additional testing shows that the materials do not conform to the specified requirements, Contractor shall pay the cost of these tests.

- b. If such additional testing shows that the materials do conform to the specified requirements, Engineer will pay the cost of these tests.

3.12 NON-CONFORMING WORK

- A. Enforcement of specification requirements:
 - 1. Do not place concrete that does not conform to the requirements of these Specifications. Remove non-conforming materials from the site.
 - 2. Strength requirements:
 - a. Concrete is expected to reach higher compressive strength than the minimum specified compressive strength f'_c as indicated in Table B of this Section.
 - b. Concrete strength will be considered acceptable if following conditions are satisfied:
 - 1) Averages of all sets of 3 consecutive strength test results are greater than or equal to specified compressive strength f'_c .
 - 2) No individual strength test (average of 2 cylinders tested at 28-days) falls below specified compressive strength f'_c by more than 500 pounds per square inch.
 - c. Whenever 1, or both of the conditions stated above is not satisfied, provide additional curing or testing of the affected portion as directed by the Engineer.
 - 1) The costs of such curing or testing shall be at the Contractor's expense.

3.13 ADJUSTING

- A. Remove and replace or repair defective work as directed by the Engineer:
 - 1. Do not patch, repair, or cover defective work before observation by the Engineer.
 - 2. Make no repairs until Engineer has accepted proposed methods for preparation and repair.

END OF SECTION

SECTION 03_35_29

TOOLED CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Tooled concrete finishes.

1.02 QUALITY ASSURANCE

- A. Mock-ups:
 - 1. Test panels indicating methods for making concrete repairs: Prepare test panels for proposed repairs at beginning of project for review by Engineer:
 - a. Accepted test panels serve as standard for repairs during the project.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Packing and shipping:
 - 1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MIXES

- A. Mortar mix for F4 finish: Consist of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

PART 3 EXECUTION

3.01 CONCRETE FINISHES

- A. Cement for finishes:
 - 1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.
- B. Finish vertical concrete surfaces with one of the following finishes as indicated in the Finish Schedule:
 - 1. F1 finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing compound.
 - 2. F2 finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2 inch or deeper and tie holes with mortar after removal of curing compound.

3. F3 finish: Repair defective work, remove fins, offsets, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing compound.
 4. F4 finish: Receive same finish as specified for F3 finish, and, in addition fill depressions and holes 1/16 inch or larger in width with mortar.
 - a. "Brush-Off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
 - b. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
 - c. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
 - d. Do not let any material remain on surfaces, except that within pits and depressions.
 - e. Wipe surfaces clean and moist cure.
- C. Finish horizontal concrete surfaces with one of the following finishes as indicated in the Finish Schedule after proper and adequate vibration and tamping:
1. S1 finish: Screeded to grade and leave without special finish.
 2. S2 finish: Smooth steel trowel finish.
 3. S3 finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
 4. S4 finish: Steel trowel finish, without local depressions or high points, followed by light hair broom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish is subject to review and acceptance by the Engineer.
 5. S5 finish: Nonslip abrasive: After concrete has been screeded level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.
 6. S6 finish: Roughened finish: After concrete has been screeded to grade, apply a roughened finish by use of a jitterbug roller or similar device.
- D. Finish concrete floor surfaces to which surfacing material is applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

3.02 CONCRETE FINISH SCHEDULE

- A. Finish concrete surfaces as follows:
1. F4 finish for following vertical surfaces:
 - a. Concrete surfaces specified or indicated to be painted.
 - b. Concrete surfaces, interior or exterior, exposed to view.
 2. Surfaces in open channels, basins, and similar structures:
 - a. F3 finish for vertical surfaces which are normally below water surface.
 - b. F4 finish for vertical surfaces located above normal water surface and exposed to view.

- c. Remove fins and fill tie holes from concrete surfaces located in closed boxes or channels where there is normally no access or passageway.
- 3. S1 finish for following surfaces:
 - a. Projecting footings which are to be covered with dirt.
 - b. Slab surfaces which are to be covered with concrete fill.
- 4. S2 finish for following surfaces:
 - a. Tops of corbels.
 - b. Tops of walls and beams not covered above in this Section.
 - c. Tops of slabs not covered above in this Section.
 - d. All other surfaces not specified to be finished otherwise.
- 5. S3 finish for following surfaces:
 - a. Building and machine room floors which are not covered with surfacing material: Provide floors that are free from trowel marks.
- 6. S4 finish for following surfaces:
 - a. Exterior walkways.
 - b. Tops of exterior walls or beams which are to serve as walkways.
 - c. Tops of exterior walls or beams which are to support gratings.
 - d. Top surface of slabs for basins, channels, digesters, and similar structures.
- 7. S6 finish for following surfaces:
 - a. Basin bottoms, or other similar slab surfaces, over which layer of basin bottom grout will be applied.

END OF SECTION

SECTION 03_60_00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Cement grout.
 - 2. Cement mortar.
 - 3. Dry-pack mortar.
 - 4. Grout.
 - 5. Non-shrink grout.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch cube specimens).
 - 2. C230 - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - 3. C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - 4. C579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
 - 5. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - 6. C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
 - 7. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
 - 8. C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
- B. International Concrete Repair Institute (ICRI):
 - 1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

- A. Cement grout:
 - 1. Mix design.
 - 2. Material submittals.
- B. Cement mortar:
 - 1. Mix design.
 - 2. Material submittals.

- C. Non-shrink grout:
 - 1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.
- B. Store materials in cool dry place and in accordance with manufacturer's recommendations.
- C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Non-shrink grout:
 - 1. Manufacturers: One of the following or equal:
 - a. Five Star Products, Inc., Five Star Grout.
 - b. Master Builder Solutions, MasterFlow 928.
 - c. L&M Construction Chemicals, Inc., CRYSTEX.
 - 2. In accordance with ASTM C1107.
 - 3. Pre-portioned and prepackaged cement-based mixture.
 - 4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
 - 5. Require only addition of potable water.
 - 6. Water for pre-soaking, mixing, and curing: Potable water.
 - 7. Free from emergence of mixing water from within or presence of water on its surface.
 - 8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230.
 - a. If at fluid consistency, verify consistency in accordance with ASTM C939.
 - 9. Dimensional stability (height change):
 - a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
 - b. Have 90 percent or greater bearing area under bases.
 - 10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

- A. Cement grout:
 - 1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
 - 2. Use same materials for cement grout that are used for concrete.

3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
 4. For spreading over surfaces of construction or cold joints.
- B. Cement mortar:
1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
 2. Use same materials for cement mortar that are used for concrete.
 3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
 4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.
- C. Dry-pack mortar:
1. Proportions by weight: 1 part Portland cement to 2 parts concrete sand.
 - a. Portland cement: As specified in Section 03_30_01 – Concrete Work .
 - b. Concrete sand: As specified in Section 03_30_01 – Concrete Work .
- D. Grout:
1. Mix in proportions by weight: 1 part Portland cement to 4 parts concrete sand.
 - a. Portland cement: As specified in Section 03_30_01 – Concrete Work.
 - b. Concrete sand: As specified in Section 03_30_01 – Concrete Work.
- E. Non-shrink grout:
1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

- A. Surface preparation for grouting other baseplates:
1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
 2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher.
 - a. Remove loose or broken concrete.
 3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

- A. Mixing:
 - 1. Cement grout:
 - a. Use mortar mixer with moving paddles.
 - b. Pre-wet mixer and empty out excess water before beginning mixing.
 - 2. Cement mortar:
 - a. Use mortar mixer with moving paddles.
 - b. Pre-wet mixer and empty out excess water before beginning mixing.
 - 3. Dry-patch mortar:
 - a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
 - 4. Non-shrink grout:
 - a. May be dry packed, flowed, or pumped into place. Do not overwork grout.
 - b. Do not retemper by adding more water after grout stiffens.
- B. Placement:
 - 1. Cement grout:
 - a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
 - b. Do not use cement grout that has not been placed within 30 minutes after mixing.
 - 2. Cement mortar:
 - a. Use mortar mixer with moving paddles.
 - b. Pre-wet mixer and empty out excess water before beginning mixing.
 - 3. Non-shrink grout:
 - a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
 - b. Mix in accordance with manufacturer's instructions to uniform consistency.
- C. Curing:
 - 1. Cement based grouts and mortars:
 - a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
 - b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.
- D. Grouting equipment bases, baseplates, soleplates, and skids: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- E. Grouting other baseplates:
 - 1. General:
 - a. Use non-shrink grout as specified in this Section.
 - b. Baseplate grouting shall take place from one side of baseplate to other in continuous flow of grout to avoid trapping air in grout.
 - c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.

- d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.
- 2. Forms and headboxes:
 - a. Build forms using material with adequate strength to withstand placement of grouts.
 - b. Use forms that are rigid and liquid tight. Caulk cracks and joints with elastomeric sealant.
 - c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
 - d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on one side of baseplate.
 - e. After grout sets, remove forms and trim back grout at 45 degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

- A. Non-shrink grout:
 - 1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION

SECTION 05_05_24

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Cast-in anchors and fasteners:
 - a. Anchor bolts.
 - b. Anchor rods.
 - c. Concrete inserts.
 - 2. Post-installed steel anchors and fasteners:
 - a. Concrete anchors.
 - b. Sleeve anchors.
 - c. Screw anchors.
 - 3. Appurtenances for anchoring and fastening:
 - a. Anchor bolt sleeves.
 - b. Isolating sleeves and washers.
 - c. Thread coating for threaded stainless steel fasteners.

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. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
 - 3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 6. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

7. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 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. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 DEFINITIONS

- A. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.
- B. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.
- C. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60 degrees above a horizontal line so that the fastener resists sustained tension loads.
- D. 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.
- E. 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.
- F. Terms relating to structures or building environments as used with reference to anchors and fasteners:
 1. Corrosive locations: Describes interior and exterior locations as follows:
 - a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
 - b. Exterior and interior locations at the following treatment structures:
 - 1) Water treatment facilities: Liquids stream:
 - a) Monitoring and injection wells
 2. 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:
 - a. Exterior portions of buildings and structures.

- b. Liquid-containing structures:
 - 1) Locations at and below the maximum operating liquid surface elevation.
 - 2) Locations above the maximum operating liquid surface elevation and:
 - a) Below the top of the walls containing the liquid.
 - b) 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).
- c. Liquid handling equipment:
 - 1) Bases of pumps and other equipment that handles liquids.
- d. Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.
- e. Other locations indicated on the Drawings.
- 3. Other locations:
 - a. Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 SUBMITTALS

- A. General:
 - 1. Submit as specified in Section 01_33_00 - Submittal Procedures.
 - 2. Submit information listed for each type of anchor or fastener to be used.
- B. Action submittals:
 - 1. Product data:
 - a. Cast-in anchors:
 - 1) Manufacturer's data including catalog cuts showing anchor sizes and configuration, materials, and finishes.
 - b. Post-installed anchors:
 - 1) For each anchor type, manufacturer's data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.
 - 2. Samples:
 - a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.
 - 3. Certificates:
 - a. Cast-in anchors:
 - 1) Mill certificates for steel anchors that will be supplied to the site.
 - b. Post-installed anchors:
 - 1) Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.
 - 4. Test reports:
 - a. Post-installed anchors: For each anchor type used for the Work:
 - 1) Current ICC-ES Report (ESR), or equivalent acceptable to the Engineer and the authority having jurisdiction, demonstrating:
 - a) Acceptance of that anchor for use under the building code specified in Section 01_41_00 - Regulatory Requirements.

5. Manufacturer's instructions:
 - a. Requirements for storage and handling.
 - b. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
 - c. Requirements for inspection or observation during installation.
6. Qualification statements:
 - a. Post-installed anchors: Installer qualifications:
 - 1) Submit list of personnel performing installations and include date of manufacturer's training for each.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Post installed anchors shall be in accordance with building codes specified in Section 01_41_00 - 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.
- B. Special inspection:
 1. Provide special inspection of post-installed anchors as specified in Section 01_45_24 - Regulatory Quality Assurance and this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.
- B. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.
- C. Protect anchors from weather and moisture until installation.

1.07 PROJECT CONDITIONS

- A. Seismic Design Category (SDC) for structures as specified in Section 01_81_50 – Design Criteria.

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 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 in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

- A. Anchor bolts:
- 1. Description:
 - a. Straight steel rod having one end with an integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
 - b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer.
 - 1) Rods or bars with angle bend for embedment in concrete (i.e., "L" or "J" shaped anchor bolts) are not permitted in the Work.
 - 2. Materials:
 - a. Ship anchor bolts with properly fitting nuts attached.
 - b. Type 316 stainless steel:
 - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
 - 2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
 - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
 - 4) Washers: Type 316 stainless steel.
 - c. Type 304 stainless steel:
 - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
 - 2) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
 - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
 - 4) Washers: Type 304 stainless steel.
 - d. Galvanized steel:
 - 1) Hot-dip galvanized coating in accordance with ASTM F2329.
 - 2) Bolt: ASTM F1554, Grade 36, heavy hex, coarse thread.
 - 3) Nuts: ASTM A563, Grade A, heavy hex, threads to match bolt.
 - 4) Washers: ASTM F436, Type 1.

- B. Anchor rods:
1. Description: Straight steel rod having threads on each end. One threaded end is fitted with nuts or plates and embedded in concrete to the effective depth indicated on the Drawings, leaving the opposite threaded end to project clear of the concrete face as required for the connection to be made at that location.
 2. Materials:
 - a. Stainless steel: Type 316:
 - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
 - 2) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
 - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
 - 4) Washers: Type 316 stainless steel.
 - 5) Plates (embedded): ASTM A240.
 - b. Stainless steel: Type 304:
 - 1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
 - 2) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
 - 3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads or rods.
 - 4) Washers: Type 304 stainless steel.
 - 5) Plates (embedded): ASTM A240.
 - c. Galvanized: steel:
 - 1) Hot-dip galvanized with coating in accordance with ASTM F2329.
 - 2) Rod: ASTM F1554, Grade 36, coarse thread.
 - 3) Nuts: ASTM A563, Grade A, threads to match rod.
 - 4) Washers: ASTM F436, Type 1.
 - 5) Plates (embedded): ASTM A36.
- C. Concrete insert: Ductile embed:
1. Description: 1-piece, integrally hot forged sleeve for embedment in concrete. Provided with flange for nailing to forms and female threaded coupler at the exposed concrete face, and washer-faced hex headed foot to resist pullout from concrete at the embedded end.
 2. Manufacturers: The following or equal:
 - a. Dayton Superior, F-54 Ductile Embed Insert.
 3. Materials:
 - a. Galvanized steel:
 - 1) Hot-dip galvanized coating in accordance with ASTM A123 or A153 where indicated on the Drawings.
 - 2) Steel: ASTM A29 hot rolled, Grade 1045.

2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE

- A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete: As specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:

1. Post-installed anchors used for the Work shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01_41_00 - 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. Conditions of use: The 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.
2. Substitutions: When requesting product substitutions, 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.
 - a. Calculations shall be prepared by and shall bear the signature and seal of a Professional Engineer licensed in the State of Florida.
 - b. Decisions regarding the acceptability of proposed substitutions shall be at the discretion of the Engineer.

B. Concrete anchors:

1. Description. 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 anchors for anchorage to concrete:
 - a. Acceptance criteria:
 - 1) Concrete anchors 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).
 - 2) Concrete anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
 - b. Manufacturers: One of the following or equal:
 - 1) Hilti, Kwik Bolt TZ Expansion Anchor.
 - 2) DEWALT/Powers, PowerStud.
 - 3) Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.

- c. Materials. Integrally threaded stud, wedge, washer, and nut:
 - 1) Stainless steel: Type 316.
 - a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
 - 2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).
- C. Flush shells:
 - 1. Description: Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
 - 2. Flush shell anchors are not permitted in the Work.
- D. Sleeve anchors:
 - 1. Description: Post-installed, torque-controlled anchor assembly consisting of an externally threaded stud with a spacer sleeve near the surface of the base material, and an expansion sleeve on the lower part of the stud. The expansion sleeve is forced outward by torquing of the center stud to transfer load.
 - a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials in order to develop holding power.
 - 2. Sleeve anchors for anchorage to concrete:
 - a. Acceptance criteria:
 - 1) Sleeve anchors 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).
 - 2) Sleeve anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
 - b. Manufacturers: One of the following or equal:
 - 1) Hilti, HSL-3 Heavy Duty Expansion (sleeve) Anchor.
 - 2) DEWALT/Powers, Power Bolt+ Heavy Duty Sleeve Anchor.
 - c. Materials:
 - 1) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).
- E. Screw anchors:
 - 1. Description: 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. Acceptance criteria:
 - 1) Screw anchors 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).
- 2) Screw anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
- b. Manufacturers: Screw anchor: One of the following or equal:
 - 1) Hilti, Hex head, HUS-EZ Screw Anchor:
 - a) With internally threaded head: HUS-EZ I Hanger Anchor.
 - 2) DEWALT/Powers, Screwbolt+ Screw Anchor:
 - a) With internally threaded head: Vertigo+ Rod Hanging System.
 - 3) Simpson Strong-Tie, Titen® HD Screw Anchor:
 - a) With internally threaded head: Titen® HD Rod Hanger.
- c. Materials:
 - 1) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5) or equal.

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

- A. Anchor bolt sleeves:
 - 1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.
 - 2. Plastic sleeves:
 - a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.
 - b. Manufacturers: The following or equal:
 - 1) Portland Bolt & Manufacturing Co.
 - 3. 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 anchor bolts:
 - 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 anchor bolts:
 - 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.
- B. Isolating sleeves and washers:
 - 1. Manufacturers: One of the following or equal:
 - a. Central Plastics Co.
 - b. Allied Corrosion Industries.

2. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending halfway into both steel washers.
 3. One sleeve is required for each bolt.
 4. Washers: The inside diameter of all washers shall fit over the isolating sleeve, and both the steel and isolating washers shall have the same inside diameter and outside diameter.
 - a. Proper size to fit bolts.
 - b. Two 1/8-inch thick steel washers for each bolt.
 - c. G3 Phenolic: 2 insulating washers are required for each bolt:
 - 1) Thickness: 1/8 inch.
 - 2) Base material: Glass.
 - 3) Resin: Phenolic.
 - 4) Water absorption: 2 percent.
 - 5) Hardness (Rockwell): 100.
 - 6) Dielectric strength: 450 volts per mil.
 - 7) Compression strength: 50,000 pounds per square inch.
 - 8) Tensile strength: 20,000 pounds per square inch.
 - 9) Maximum operating temperature: 350 degrees Fahrenheit.
- C. Coating for repair of galvanized surfaces:
1. Manufacturers: The following or equal:
 - a. Jelt, Galvinox.
- D. 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. Take special care to 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: CAST-IN ANCHORS

- A. General:
 - 1. Accurately locate cast-in and built-in anchors.
 - a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
 - b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
 - c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
 - d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
 - 2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
 - 3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.
- B. Anchor bolts:
 - 1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.
 - 2. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment. Seal top of sleeve to prevent grout from filling sleeve.
- C. Anchor rods:
 - 1. Install as specified for anchor bolts.
- D. Concrete inserts:
 - 1. Provide inserts with minimum clear concrete cover not less than that specified for reinforcing bars.

3.04 INSTALLATION: POST-INSTALLED ADHESIVE ANCHORS

- A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03_21_17 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

3.05 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 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 all 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 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 full 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			
Nominal Diameter	Minimum Effective Embedment Length		Minimum Member Thickness
	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. Flush shell anchors:
 1. Flush shell anchors are not permitted in the Work.
 2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact Engineer for instructions before proceeding.
- F. Sleeve anchors:
 1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Sleeve Anchors			
Nominal Diameter	Minimum Effective Embedment Length		Minimum Member Thickness
	In Concrete	In Grouted Masonry	
M8 (1/2 inch)	70 mm (2 3/4 inch)	Not accepted	100 mm (8 inch)
M10 (5/8 inch)	76 mm (3 inch)	Not accepted	250 mm (10 inch)
M12 (3/4 inch)	80 mm (3 1/4 inch)	Not accepted	300 mm (12 inch)

2. Install with the sleeve fully engaged in the base material.

- G. Screw anchors:

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

Screw Anchors			
Nominal Diameter	Minimum Effective Embedment Length		Minimum Member Thickness
	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

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

3.06 FIELD QUALITY CONTROL

- A. Contractor shall provide quality control over the Work of this Section as specified in Section 01_45_00 - Quality Control.
 1. Expenses associated with work described in 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 to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 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 in 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 manufacturer's installation instructions for the products used.
 2. Record of inspections:
 - a. Maintain record of each inspection.
 - b. Submit copies to 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. Sleeve anchors.
 - c. 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 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. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.
- E. Field tests:
1. Owner's Representative 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.

3.08 NON-CONFORMING WORK

- A. Remove misaligned or non-performing anchors.
- B. Fill empty anchor holes and repair failed anchor locations as specified in Section 03_60_00 - Grouting 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.

3.09 SCHEDULES

- A. Stainless steel. Provide and install stainless steel anchors at the following locations:
 1. "Corrosive locations" as defined in this Section: Type 316 stainless steel.
 2. "Wet and moist locations" as defined in this Section: Type 316 stainless steel.

3. "Other locations:"
 - a. For connecting stainless steel members to concrete or masonry: Match alloy of stainless steel members.
 - b. For connecting aluminum members to concrete or masonry.
 - c. For connecting fiber-reinforced plastic (FRP) members to concrete or masonry.
 4. At locations indicated on the Drawings.
- B. Galvanized: Provide and install galvanized carbon steel anchors at the following locations:
1. Locations not requiring stainless steel.
 2. At locations indicated on the Drawings.

END OF SECTION

SECTION 06_80_17

FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Fiberglass reinforced plastic fabrications including:
 - 1. Grating.

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. D638 - Standard Test Method for Tensile Properties of Plastics.
 - 3. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 4. D2583 - Standard Test Method for Indentation of Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - 5. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. Submit general arrangement and fabrication drawings, calculations, and elements of the design for grating.
- B. Product Data.
- C. Manufacturer's Installation Instructions.

PART 2 PRODUCTS

2.01 GRATING

- A. Manufacturers: One of the following or equal:
 - 1. Fibergrate Composite Structures, Safe-T-Span.
 - 2. Strongwell, Duradek.
- B. Materials:
 - 1. Core: Unidirectionally aligned glass fibers.
 - 2. Mat: Submit standard corrosion liner.
 - 3. Veil: Submit standard corrosion liner.
 - 4. Ultraviolet stabilizer: Added to the exterior surfaces in the type and amount recommended by the resin manufacturer.

5. Resin: Fire retardant premium vinyl ester, antimony trioxide or pentoxide added to meet Class I flame spread rating of ASTM E84 and self-extinguishing requirements of ASTM D635.
 6. Manufacturers: One of the following or equal:
 - a. Dow Derakane 530.
 - b. Ashland Hetron 992.
 - c. Interplastic VE 8400.
 - d. Reichhold Dion VER 9300FR.
 7. Color: Grey or as indicated on the Drawings.
 8. Anti-slip coating: Permanently bonded grit of selected color.
- C. Design criteria and chemical exposure:
1. Deflection and concentrated load: Maximum 0.15 inch at span of 48 inches under concentrated load of 250 pounds.
 2. Deflection and uniform distributed load: Capable of carrying uniform distributed load of 100 pounds per square foot on simple span of 56 inches without deflecting more than 0.25 inches.
 3. Weight: Maximum 3.3 pounds per square foot for 2-inch high grating with open area of minimum 50 percent.
 4. Suitability: Use stairs and grating suitable for use in environments containing chlorine and sulfuric acid solutions at the temperatures and concentrations specified for the application.
- D. Components:
1. Bearing bars: I-bars, 2-inch high or depth as indicated on the Drawings, I-bars spaced at 1-3/16 inch on center.
 2. Cross bars: 3/8-inch diameter spaced at a maximum of 12 inches on center.
 3. Hold downs, connectors, and accessories: As recommended by grating manufacturer.
- E. Fabrication:
1. Produce grating bearing and cross bars by pultrusion process. Do not use hand lay-up construction methods.
 2. Coat ends of grating with resin.
 3. Fabricate single sections for each span. Do not clamp 2 or more grating sections together within spans.
 4. Type 316 stainless steel plates and angles at openings:
 - a. Install 5/8-inch thick plate or angle where required to fill openings at changes in elevation and at openings between equipment and grating.
 - b. Install angle stops at ends of grating to prevent grating from sliding.
 5. Maximum 1/8-inch clearance allowed between ends of grating and inside face of vertical leg of support angles.
- F. Accessories:
1. Rebate.
 2. Angle ledger.
 3. Grating clips.

- G. Cutouts:
 - 1. Provide where required for equipment access or penetrations, including valve operators, stems, and gate frames.
 - 2. Seal cut edges with resin.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are satisfactory for installation of products as specified in Section 01_60_00 - Product Requirements.

3.02 ERECTION AND INSTALLATION, GENERAL

- A. Install products where indicated on the Drawings in accordance with manufacturer's printed instructions.

END OF SECTION

SECTION 07_92_00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Acrylic-Latex sealant.
 - 2. Precast concrete joint sealant.
 - 3. Silicone sealant.
 - 4. Synthetic rubber sealing compound.
 - 5. Synthetic sponge rubber filler.
 - 6. Related materials.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. M198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
- B. ASTM International (ASTM):
 - 1. C920 - Standard Specification for Elastomeric Joint Sealants.
 - 2. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 - 3. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
 - 4. C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
 - 5. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
 - 6. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

1.03 SUBMITTALS

- A. Product data.
- B. Samples, include color selections.
- C. Manufacturer's Installation Instructions.
- D. Warranty.

1.04 QUALITY ASSURANCE

- A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.
- B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

- A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products in accordance with manufacturer's recommendations.
- B. Code date packages. Do not use material older than manufacturer's published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer's instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

- A. Caulk joints prior to painting.

1.08 WARRANTY

- A. Warrant to correct defective products for minimum 1 year in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SEALANTS

- A. General:
 - 1. Provide colors matching materials being sealed.
 - 2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
 - 3. Nonsagging sealant for vertical and overhead horizontal joints.
 - 4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
 - 5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
 - 6. Sealant backer rod and/or compressible filler made from closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
 - a. Control joint depth.

- b. Break bond of sealant at bottom of joint.
- c. Provide proper shape of sealant bead.
- d. Serve as expansion joint filler.

2.02 ACRYLIC-LATEX SEALANT

- A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options:
 - 1. Manufacturers: One of the following or equal:
 - a. Tremco, Tremflex 834.
 - b. Pecora Corp., Number AC-20.
 - c. Sonneborn, Sonolac.

2.03 PRECAST CONCRETE JOINT SEALANT

- A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198:
 - 1. Manufacturers: One of the following or equal.
 - a. Henry Corp., Ram-Nek.
 - b. Concrete Sealants Division, ConSeal.

2.04 SILICONE SEALANT

- A. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant:
 - 1. Manufacturers: One of the following or equal:
 - a. Tremco, Proglaze.
 - b. Pecora Corp., Number 864.
 - c. Dow Corning, Number 795.
 - d. General Electric, Number 1200 Series.

2.05 SYNTHETIC RUBBER SEALING COMPOUND

- A. Manufacturer: One of the following or equal:
 - 1. Sika Corporation, Sikaflex 2c NS or SL
 - 2. Pacific Polymers, Elastothane 227R.
- B. Material: In accordance with ASTM C920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient polymer; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
 - 1. Base: Polyurethane rubber.
 - 2. Application time: Minimum 2 hours.
 - 3. Cure time: Maximum 3 days.
 - 4. Tack free time: Maximum 24 hours.
 - 5. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
 - 6. Tensile strength: Non-sag 95 pounds per square inch minimum and self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D412.

7. Ultimate elongation: Minimum 340 percent when tested in accordance with ASTM D412.
 8. Tear resistance: Non-sag 45 pounds per inch minimum and self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D624, Die C.
 9. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.
- C. Color: Gray to match concrete, unless indicated on the Drawings.

2.06 SYNTHETIC SPONGE RUBBER FILLER

- A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. In accordance with ASTM C1330, Type C:
1. Manufacturers: The following or equal:
 - a. Presstite, No. 750.3 Ropax Rod Stock.
- B. Characteristics:
1. Suitable for application intended.
 2. Strength: As necessary for supporting sealing compound during application.
 3. Resiliency: Resistance to environmental conditions of installation.
 4. Bonding: No bonding to the sealing compound.
 5. Structure: Cellular, prevents absorption of water.
 6. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
 7. Size: Minimum 25 percent greater than nominal joint width.

2.07 RELATED MATERIALS

- A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.
- B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.
- C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify acceptability of joint dimensions, physical, and environmental conditions.
- B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

- A. Allow concrete to cure thoroughly before caulking.
- B. Synthetic sponge rubber filler:
 - 1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
 - 2. Do not stretch filler beyond its normal length during installation.
- C. Caulking:
 - 1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of sealant.
 - 2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.
- D. Synthetic rubber sealing compound:
 - 1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
 - 2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.
- E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less than 3/8 inches deep.
- F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.
- G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.
- H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.
- I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.
- J. Do not stretch filler beyond normal length during installation.
- K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

- A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.
- B. Caulking, joints, and sealing:
 - 1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
 - 2. Install pipe and conduit in structures as indicated on the Drawings.

3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.
4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
5. Complete caulking prior to painting.
6. Verify that concrete is thoroughly cured prior to caulking.
7. When filler compressible material is used, use untreated type.
8. Apply caulking with pneumatic caulking gun.
9. Use nozzles of proper shape and size for application intended.
10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.
11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.
12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

- A. Clean surfaces adjacent to sealant as work progresses.
- B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.
- C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.
- D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

- A. Acrylic latex:
 1. Use where indicated on the Drawings.
 2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.
- B. Silicone:
 1. Use where indicated on the Drawings.
 2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
 3. Door threshold bedding.
 4. Moist or wet locations, including joints around plumbing fixtures.
 5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
 6. Plenum joints.
- C. Synthetic rubber sealing compound, non-sag Type II:
 1. Use where indicated on the Drawings.
 2. Water-bearing and earth-bearing concrete structures.

3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.
 4. Joints between sheet metal flashing and trim.
 5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
 6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
 7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
 8. Expansion and control joints in masonry vertical surfaces.
- D. Synthetic rubber sealing compound, self-leveling Type I:
1. Use where indicated on the Drawings.
 2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
 3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
 4. Pavement joints.
 5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3.06 FIELD QUALITY CONTROL

- A. Adhesion testing:
1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
 - a. Water bearing structures: 1 test per every 1,000 LF of joint sealed.
 - b. Exterior precast concrete wall panels: 1 test per every 2,000 LF of joint sealed.
 - c. Chemical containment areas: 1 test per every 1,000 LF of joint sealed.
 - d. Building expansion joints: 1 test per every 500 LF of joint sealed.
 - e. All other type of joints except butt glazing joints: 1 test per every 3,000 LF of joint sealed.
 - f. Manufacturer's authorized factory representative provide written recommendations for remedial measures on failing tests.

END OF SECTION

SECTION 09_96_01

HIGH-PERFORMANCE COATINGS

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ATTACHMENT A – SCHEDULE OF SURFACES TO BE COATED

ATTACHMENT B – COATING DETAIL SHEET

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Coatings, including coating systems, surface preparation, application requirements, and quality control requirements.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - 2. D2200 – Standard Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces.
 - 3. D3359 - Standard Test Methods for Rating Adhesion by Tape Test.
 - 4. D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
 - 5. D4262 - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
 - 6. D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - 7. D4285 - Standard Test Method for Indicating Oil or Water in Compressed Air.
 - 8. D4414 - Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
 - 9. D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast-Cleaned Steel.
 - 10. D4541 - Standard Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 - 11. D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
 - 12. D5162 - Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.
 - 13. D7234 - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
 - 14. E337 - Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
 - 15. F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - 16. F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In-situ Probes.
- B. International Concrete Repair Institute (ICRI):
 - 1. 310.2 - Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
- C. NACE International (NACE):
 - 1. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
 - 2. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.

- D. National Association of Pipe Fabricators (NAPF):
 - 1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings.
- E. NSF International (NSF):
 - 1. 61 - Drinking Water System Components - Health Effects.
- F. Occupational Safety and Health Administration (OSHA).
- G. Society of Protective Coatings (SSPC):
 - 1. Glossary - SSPC Protective Coatings Glossary.
 - 2. Guide 6 - Guide for Containing Surface Preparation Debris Generated during Paint Removal Operations.
 - 3. Guide 15 - Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
 - 4. PA 1 - Shop, Field, and Maintenance Painting of Steel.
 - 5. PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
 - 6. PA 9 - Measurement of Dry Coating Thickness Using Ultrasonic Gages.
 - 7. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors.
 - 8. SP 1 - Solvent Cleaning.
 - 9. SP 3 - Power Tool Cleaning.
 - 10. SP 5 - White Metal Blast Cleaning.
 - 11. SP 10 - Near-White Metal Blast Cleaning.
 - 12. SP 11 - Power Tools Cleaning to Bare Metal.
 - 13. SP 13 - Surface Preparation of Concrete.
 - 14. SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
 - 15. SP COM - Surface Preparation Commentary.
 - 16. SP VIS 1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
 - 17. SP WJ-1 - Waterjet Cleaning of Metals -- Clean to Bare Substrate.
 - 18. SP WJ-2 - Waterjet Cleaning of Metals -- Very Thorough Cleaning.
 - 19. SP WJ-3 - Waterjet Cleaning of Metals -- Thorough Cleaning.
 - 20. SP WJ-4 - Waterjet Cleaning of Metals -- Light Cleaning.

1.03 DEFINITIONS

- A. Definitions used in this Section are in accordance with definitions referenced in ASTM D16, ASTM D3960, and SSPC Glossary of Definitions.
- B. Specific definitions:
 - 1. Abrasive: Material used for blast cleaning, such as sand, grit, or shot.
 - 2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.
 - 3. Anchor Pattern: Profile or texture of prepared surface(s).
 - 4. Biogenic Sulfide Corrosion: Corrosion caused by sulfuric acid formed when *Thiobacillus* bacteria metabolizes hydrogen sulfide.

5. Bug Holes: Small cavities resulting when air bubbles are entrapped in the surface of formed concrete during placement and consolidation.
6. System: Protective film with 1 or more coats applied in a predetermined order, including surface preparation and quality control requirements.
7. Coating/Paint/Lining Thickness: Total thickness of primer, intermediate, and/or finish coats after drying or curing.
8. Dew point: Temperature a given air/water vapor mixture starts to condense.
9. Drying Time: Time interval between application and material curing.
10. Dry to Recoat: Time interval between material application and its ability to receive the next coat.
11. Dry to Touch: Time interval between material application and its ability to tolerate a light ouch without coating damage.
12. Exposed Surface: Any indoor or outdoor surface not buried or encased.
13. Feather Edging: Reducing coating thickness at its edge to blend with existing surrounding coating.
14. Feathering: Tapering off a wet edge with a comparatively dry brush.
15. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.
16. Field Coat: Application of a surface coating system at the work site.
17. Finish Coat: Final coat in a paint system, including texture, color, smoothness of surface, and other properties affecting appearance.
18. Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
19. Holiday: A discontinuity, skip, void, or pinhole in coating or coating system film that exposes the substrate.
20. Honeycomb: Segregated and porous surface of hardened concrete due to insufficient consolidation.
21. Hydroblast: High or ultra-high-pressure water jet surface preparation.
22. Incompatibility: One coating's inability to overlay another coating or surface as evidenced by bleeding, poor bonding, or lifting of old coating; inability of a coating to bond to a substrate.
23. Immersed/Immersion: A service condition in which substrate is submerged, is immediately above liquids, or is subject to frequent wetting, splashing, or washdown.
24. Laitance: A thin, weak, brittle layer of cement and aggregate fines on a concrete surface.
25. Mil: 0.001 inch.
26. Overspray: Dry spray, particularly paint bonded to an unintended surface.
27. Pinhole: A small diameter discontinuity in a coating or coating system film, created by offgassing from a void in a concrete or masonry substrate causing a void between coats or exposing the substrate. Usually caused by coating application while temperature is rising.
28. Pot Life: Time interval after components are mixed and coating can be satisfactorily applied.
29. Prime Coat: First full paint coat applied to a surface when using a multicoat system. Primers adhere to a new substrate, protect the substrate, and promote adhesion of subsequent coats of paint. The prime coat on metal surfaces is the first full coat and does not include solvent wash, grease emulsifiers, or other pretreatment applications.

30. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-based material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
31. Shelf Life: Maximum storage time a material may be stored without losing its usefulness.
32. Shop Coat: 1 or more coats applied in an off-site shop or plant before shipment to work site where field or finishing coat(s) are applied.
33. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
34. Stripe Coat: A separate brush coat of paint applied to all weld seams, pits, nuts/bolts/washers, and edges. This coat shall not be applied until previous coats have cured. Once applied, the coat shall be allowed to cure before subsequent coats are applied.
35. Tie Coat: An intermediate coat that bonds different types of paint material, improving succeeding coat adhesion.
36. Thick Film Coating System: A coating system applied with a minimum dry film thickness of 25 mils.
37. Touch-Up Painting: Application of paint on previously painted surfaces to repair marks, scratches, and deteriorated or damaged areas to restore the appearance and performance of the coating.
38. Water Blast: An alternative to air abrasive blast cleaning that can be used with or without abrasive injection. Water cleaning at pressures up to 5,000 pounds per square inch is called low-pressure water cleaning or power washing. High-pressure water cleaning uses water pressures between 5,000 and 10,000 pounds per square inch. Water jetting is water blasting with added abrasive at pressures between 10,000 and 25,000 pounds per square inch. Ultra-high-pressure water jetting is water blasting at pressures above 25,000 pounds per square inch.
39. Weld Splatter: Beads of non-structural weld metal that adhere to the surrounding surface, removed as part of surface preparation.

1.04 ABBREVIATIONS

- A. CSM - Coating System Manufacturer.
- B. CMU - Concrete Masonry Units.
- C. CSA - Coating System Applicator. Specialty subcontractor retained by the Contractor to install the coating systems specified in this Section.
- D. CTR - Coating System Manufacturer's Technical Representative.
- E. DFT - Dry-Film Thickness. Thickness of cured film, usually expressed in mils (0.001 inch).
- F. SSD - Surface Saturated Dry. Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.
- G. TPC - Technical Practice Committee.

- H. VOC - Volatile Organic Compound. Portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing; expressed in grams per liter (g/l) or pounds per gallon (lb/gal). VOC is determined by EPA Method 24.
- I. WFT - Wet Film Thickness. Coating thickness as measured immediately after application. Usually expressed in mils (0.001 inch).

1.05 SUBMITTALS

- A. As specified in Section 01_33_00 - Submittal Procedures, submit the following:
 - 1. Schedule of proposed coating materials.
 - 2. Schedule of surfaces to be coated with each coating material.
 - 3. Dehumidification and heating plan.
 - 4. Product data:
 - a. Physical properties of coatings, including the following:
 - 1) Solids content.
 - 2) Ingredient analysis.
 - 3) VOC content.
 - 4) Temperature resistance.
 - 5) Typical exposures and limitations.
 - 6) Manufacturer's standard color chips.
 - b. Compliance with regulatory requirements:
 - 1) VOC limitations.
 - 2) Lead compounds and polychlorinated biphenyls.
 - 3) Abrasives and abrasive blast cleaning techniques and disposal.
 - 4) Methods for tenting blasting areas and methods to protect existing equipment from dust and debris.
 - 5) NSF certification of coatings for potable water supply systems.
 - c. CSM's current printed recommendations and product data sheets for coating systems, including:
 - 1) Surface preparation recommendations.
 - 2) Primer type.
 - 3) Maximum dry and wet-mil thickness per coat and number of coats.
 - a) Coating Coverage Worksheets.
 - 4) Minimum and maximum curing time between coats, including atmospheric conditions for each.
 - 5) Curing time before submergence in liquid.
 - 6) Thinner to be used for each coating.
 - 7) Ventilation requirements.
 - 8) Minimum and maximum atmospheric conditions during which the paint shall be applied.
 - 9) Allowable application methods.
 - 10) Maximum allowable substrate moisture content.
 - 11) Maximum shelf life.
 - 12) Requirements for transportation and storage.
 - 13) Mixing instructions.
 - 14) Shelf life.
 - 15) Material Pot life.
 - 16) Precautions for applications free of defects.
 - 17) Method of application.

- 18) Drying time of each coat, including prime coat.
- 19) Compatible prime coats.
- 20) Limits of ambient conditions during and after application.
- 21) Required protection from sun, wind, and other conditions.
- 22) Touch-up requirements and limitations.
- 23) Minimum adhesion of each system submitted in accordance with ASTM D4541 and ASTM D7234.
- d. Samples: Include 8-inch square drawdowns or brushouts of topcoat finish when requested. Identify each sample as to finish, formula, color name and number, sheen name, and gloss units.
- e. Affidavits signed by an officer of the CSM's corporation attesting to full compliance of each coating system component with current federal, state, and local air pollution control regulations and requirements.
- f. List of cleaning and thinner solutions allowed by the CSMs.
- g. Storage requirements, including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
- h. Thick film coating systems (greater than 25 mils):
 - 1) CSM's detailed written instructions for coating system treatment and graphic details for coating system terminations in coated structures, including pipe penetrations, metal embedment's, gate frames, and other terminations encountered.
 - 2) Include detail treatment for coating system at concrete joints.
 - 3) Manufacturer's Representative's (CTR) Field Reports.
- 5. Quality assurance submittals:
 - a. Quality assurance plan.
 - b. Qualifications of CSA, including:
 - 1) List of Similar Projects.
 - a) Name and address of project.
 - b) Year of installation.
 - c) Year placed in operation.
 - d) Point of contact: Name and phone number.
 - 2) Provide a minimum of 5 project references, each including contact name, address, and telephone number where similar coating work has been performed by their company in the past 5 years.
 - c. CSA Reports:
 - 1) Written daily quality control inspection reports.
 - d. CTR Reports:
 - 1) Reports on visits to project site to view and approve surface preparation of structures to be coated.
 - 2) Reports on visits to project site to observe and approve coating application procedures.
 - 3) Reports on visits to coating plants to observe and approve surface preparation and coating application on shop-coated items.

1.06 QUALITY ASSURANCE

- A. CSA qualifications:
 - 1. Minimum of 5 years of experience applying specified type or types of coatings under conditions similar to those of the Work:
 - a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 5 years.
 - 2. SSPC QP 1 certified.
 - 3. Manufacturer-approved applicator when manufacturer has approved applicator program or when required in these specifications.
- B. CTR qualifications:
 - 1. Certification, one of the following:
 - a. NACE Level 2 or 3 Certified Coating Inspector.
 - b. SSPC Level 3 Protective Coatings Inspector.
 - 2. Minimum of 5 years of experience evaluating application of manufacturer's coatings under conditions similar to those of the Work:
 - a. Provide CTR qualifications and references listing 5 similar projects completed in the past 5 years.
- C. Regulatory requirements: Comply with governing agencies' regulations by using coatings conforming to their VOC limits.
 - 1. Lead-based coatings are not permitted.
 - 2. Do not use coal-tar epoxy in contact with drinking water or exposed to ultraviolet radiation.
- D. Pre-installation conference: Conduct as specified in Section 01_31_19 - Project Meetings.
 - 1. Coordinate Hold Point schedule
- E. Field samples:
 - 1. Prepare and coat a minimum 100-square-foot area of each system between corners or limits such as control or construction joints.
 - 2. Approved field sample may be part of the Work.
- F. Obtain approval before coating other surfaces. Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.
- G. CSM services:
 - 1. CSA shall arrange for CTR to attend pre-installation conferences.
 - 2. Visit the project site periodically to consult on and inspect specified surface preparation and application Hold Points.
 - 3. Visit coating plants to observe and approve surface preparation procedures and coating application of items to be shop primed and coated.
 - 4. CTR shall provide written inspection reports.

H. Quality control requirements:

1. Contractor shall be responsible for the workmanship and quality of the coating system installation.
 - a. Inspections by Owner, Engineer, CSA, or CTR will not relieve or limit Contractor's responsibilities.
2. Conform to this specification's requirements and the standards referenced in this Section. Changes in the coating system application requirements will be allowed only with the Engineer's written acceptance.
3. Specially trained crews with experience applying the specified coating system coating are required for:
 - a. Coating application using plural component spray equipment or other specialty equipment.
 - b. Coating with specialty linings for severe service conditions, including floor coatings, and with linings for corrosive headspaces or secondary containment areas.
4. CTR shall specially train personnel for coating systems as specified in Attachment B - Coating Detail Sheets.
 - a. CSM shall approve personnel in writing applying the coating system.
5. Do not use contaminated, outdated, diluted materials, and/or materials from previously opened containers.
6. Identify inspection access points used by Owners or Engineers.
7. Provide ventilation, ingress, egress, or other means as necessary for Owner's or Engineer's personnel to safely access the work areas.
8. Conduct and continually inspect work so the coating system is installed as specified. The CSM shall provide written directions to correct coating work not conforming to the specifications or is otherwise unacceptable.
9. Provide written daily reports summarizing test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system application.
 - a. Determine relative humidity in accordance with ASTM E337. Confirm other conditions, such as proper protective measures for surfaces not to be coated and safety requirements for personnel.
 - 1) Measure daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
 - 2) Determine the acceptability of weather and/or environmental conditions within the structure in accordance with the CSM's requirements.
 - b. Monitoring surface preparation: Spot check cleanliness, surface profile, and surface pH testing at least 3 times daily. Check each surface at least once. In accordance with:
 - 1) ASTM D4262.
 - 2) ASTM D4263.
 - 3) ASTM D4417.
 - 4) ICRI 310.2 requirements.
 - 5) SSPC Surface Preparation Standards.
 - c. Confirm that compressed air used for surface preparation or blow-down cleaning is free of oil and moisture.
 - d. Monitor surface preparation daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
 - e. Do not apply coatings when environmental conditions are outside of the CSM's published limits.

- f. Monitoring coatings application: Continuously inspect, measure, and record the wet film thickness and general film quality (visual inspection) for runs, sags, pinholes, holidays, etc. during coating.
 - 1) Perform WFT measurements in accordance with ASTM D4414.
 - g. Post cure evaluation: Measure and inspect the overall dry film thickness on all surfaces. Conduct a DFT survey and perform adhesion testing, holiday detection, or cure testing as required in this Section and/or the CSM's written instructions. Perform all applicable tests in accordance with ASTM D4541, ASTM D4787, ASTM D5162, ASTM D7234, SSPC-PA 1, SSPC-PA 2, SSPC-PA 9, and other pertinent standards and recommended practices.
- I. Inspection at Hold Points:
- 1. Conduct inspections at Hold Points during the coating system application and record the results.
 - 2. Coordinate Hold Points with the Engineer so the Engineer can observe Contractor's inspections on a scheduled basis.
 - 3. Provide the Engineer a minimum of 24 hours of notice before conducting Hold Point Inspections.
 - 4. Hold Points shall be as follows:
 - a. Conditions before surface preparation: Before starting surface preparation, observe, record, and confirm that oil, grease, and/or soluble salts are gone from the surface.
 - b. Post surface preparation: After completing surface preparation, measure and inspect for cleanliness and proper surface profile as specified in this Section and in the CSM's written instructions.
 - c. Coatings application: At the beginning of any coating system application, measure, record, and confirm acceptability of surface and ambient air temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
 - d. Post application inspection: Identify defects in application work on all surfaces, including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness, and other problems.
 - e. Follow-up corrective actions and final inspection: Measure and re-inspect corrective coating work performed to repair defects at prior Hold Points, and repeat until the surface condition is acceptable. Conduct final visual inspection with follow-up tests, such as holiday detection, adhesion tests, and DFT surveys.
 - f. Coatings application: At the beginning of coating system application, measure, record, and confirm acceptability of surface and ambient air temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
 - 1) Observe conditions during the Pre-application Meeting.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products as specified in Section 01_60_00 - Product Requirements.
- B. Immediately remove unspecified and unapproved coatings from Project site.

- C. Deliver new labeled, unopened containers:
 - 1. Do not deliver materials after manufacturer's expiration date or over 12 months from manufacturing date, whichever is more stringent. Store materials in well-ventilated enclosed structures and protect from weather and excessive heat or cold in accordance with the CSM's recommendations.
 - a. Store flammable materials in accordance with federal, state, and local requirements.
 - b. Store rags and cleanup materials appropriately to prevent fire and spontaneous combustion.
 - 2. Store and dispose of hazardous waste in accordance with federal, state, and local requirements. This requirement specifically applies to waste solvents and coatings.
 - 3. Container labels shall show the following:
 - a. Brand name or product title.
 - b. CSM's batch number.
 - c. CSM's manufacture date.
 - d. CSM's name.
 - e. Generic material type.
 - f. Application and mixing instructions.
 - g. Hazardous material identification label.
 - h. Shelf life expiration date.
 - i. Color.
 - j. Mixing and reducing instructions.
 - 4. Clearly mark containers to indicate safety hazards associated with the use of or exposure to materials.

1.08 PROJECT CONDITIONS

- A. Apply coatings to dry surfaces.
 - 1. Surface moisture: Comply with manufacturer's requirements or as specified in this Section.
 - a. Plaster and gypsum wallboard: 12 percent.
 - b. Masonry and concrete block: 12 percent.
 - c. Interior located wood: 15 percent.
 - d. Concrete floors: Moisture vapor transmission rate of no more than 3.0 pounds per 1,000 square feet per 24 hours in accordance with ASTM F1869 or relative humidity no greater than 80 percent if tested in accordance with ASTM F2170 unless the CSM's recommendations are more restrictive.
 - e. Concrete structures: Negative results from Plastic Sheet Test in accordance with ASTM D4263, and maximum of 80 percent relative humidity in accordance with ASTM F2170.
- B. Do not apply coatings when the following conditions exist. If such conditions exist, provide containment, covers, environmental controls, and other necessary measures.
 - 1. During rainy, misty, or damp weather, or to surfaces with frost or condensation.
 - 2. When the surface temperature is below 10 degrees Fahrenheit above the dew point.

3. When ambient or surface temperature:
 - a. Is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
 - b. Is less than 65 degrees Fahrenheit for clear finishes, unless manufacturer allows a lower temperature.
 - c. Exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
 - d. Exceeds manufacturer's recommendation.
 4. When relative humidity is higher than 85 percent.
 5. Under dusty or adverse environmental conditions.
 6. When light on surfaces measures less than 15 foot-candles.
 7. When wind speed exceeds 15 miles per hour.
- C. Apply coating only under evaporation conditions rather than condensation.
1. Use dehumidification equipment, fans, and/or heaters inside enclosed areas to maintain required atmospheric and surface temperature requirements for proper coating application and cure.
 2. Measure and record relative humidity and air and surface temperatures at the start and end of each shift to confirm proper humidity and temperature levels inside the work area.
 - a. Submit test results.
- D. Continuously ventilate, dehumidify, and heat enclosed spaces with high humidity during surface preparation, coating application, and curing.
1. Maintain minimum air temperature of 55 degrees Fahrenheit and 10 degrees Fahrenheit above the dew point.
 2. Maintain dew point of at least 10 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is performed.
 3. Reduce dew point temperature in conditioned space by at least 10 degrees Fahrenheit within 20 minutes.
 4. Seal work areas and maintain positive pressure per dehumidification equipment supplier's recommendations.
 5. Maintain these conditions before, during, and after application to ensure proper adhesion and cure of coatings for no less than:
 - a. Entire curing period.
 - b. 8 hours after coating.
- E. Systems:
1. Site electrical power availability as specified in Section 01_50_00 - Temporary Facilities and Controls.
 2. Internal combustion engine generators may be used.
 - a. Obtain required permits and provide air pollution and noise control devices on equipment as required by permitting agencies require.
 - b. Comply with state, federal, and local fire and explosion protection measures when locating and operating generator.
 - c. Locate engine generator outside hazardous classified areas per NFPA 820.
 - d. Provide daily fuel service for generator for duration of use.
 3. Dehumidification:
 - a. Provide desiccant or refrigeration drying.

- b. Use only desiccant types with a rotary desiccant wheel capable of continuous operation.
 - c. Liquid, granular, or loose lithium chloride drying systems are not acceptable.
 - 4. Heating:
 - a. Use electric, indirect combustion, or steam coil.
 - b. Direct-fired combustion heaters are not acceptable heat sources during abrasive blasting, coating application, or coating cure.
 - 5. Filters:
 - a. Use a filtration system for dust removal designed to not interfere with dehumidification equipment's ability to control dew point and relative humidity inside the reservoir.
 - b. Do not allow air from the working area or dust filtration equipment to recirculate through their dehumidifier during coating application or when solvent vapors are present.
 - 6. Design and submittals:
 - a. Prepare and submit dehumidification and heating plan, including all equipment and operating procedures.
 - b. Suppliers of services and equipment shall have at least 3 years of experience in similar applications.
- F. Provide containment and ventilation system components in accordance with SSPC- Guide 6, Level 3 and as required for hazardous materials.

1.09 MAINTENANCE

- A. Provide table of products applied organized by surface type. List coating manufacturer, color, color formulation, distributor name, telephone number, and address.

1.10 CTR RESPONSIBILITIES

- A. General:
 - 1. Attend pre-installation conference.
 - 2. Perform onsite application training.
 - 3. Periodically inspect coating system application.
- B. Coating system installation training:
 - 1. Provide a minimum of 8 hours of classroom and off-site training for application personnel and supervisory personnel in one of the following ways:
 - a. Train a minimum of 2 supervisory personnel and 2 application personnel.
 - b. Submit a letter from the CSM stating that CSM approves the supervisory and application personnel, listed by name and responsibility, and no additional training is required.
 - 2. CTR can train up to 14 application personnel and 3 supervisory personnel at a time.
 - 3. Minimum training requirements:
 - a. Explain in detail the mixing, application, curing, and termination requirements.
 - b. Provide hands-on demonstration of coating system mixing.

- c. Explain in detail the ambient condition requirements for temperature and humidity.
 - d. Explain in detail the surface preparation requirements.
 - e. Explain in detail the re-coat times, cure times, and related ambient condition requirements.
 - f. Write a letter stating that training was satisfactorily completed by the personnel, listed by name and responsibility.
 - 4. Provide special training as specified in the Coating Detail Sheets.
- C. Coating system inspection:
- 1. CTR inspection is in addition to the CSA's inspection as specified in this Section.
 - 2. Be on-site to oversee:
 - a. Coating application at least once a week.
 - b. End of surface preparation.
 - c. During coating application.
 - d. Post-cure inspection.
 - 3. Routinely inspect and verify in writing that application personnel have successfully performed surface preparation, filler/surfacer application, coating system application, and Quality Control Inspection in accordance with this Section and to warrantable quality.
 - 4. Perform the following activities to confirm conformance with the specifications:
 - a. Inspect ambient conditions during coating system installation at Hold Points for conformance with the specified requirements.
 - b. Inspect each coated surface type and coating system applied to verify the following:
 - 1) Cleanliness.
 - 2) Surface pH for concrete substrates.
 - 3) Confirm surface preparation of substrates where coating system will terminate or will be applied for conformance to the specified application criteria.
 - c. Verify surface profile of substrates by completing the following:
 - 1) Inspect preparation and application of coating detail treatment at terminations, transitions, metal embedment's in concrete, and joints and cracks in substrates.
 - 2) Inspect application of filler/surfacer materials for concrete and masonry substrates.
 - 3) Verify proper mixing of coating materials.
 - 4) Inspect application of primers and finish coats, including wet and dry film thickness.
 - 5) Inspect coating systems for proper cure times and conditions.
 - d. Review adhesion testing of cured coating systems.
 - e. Review coating system continuity testing.
 - f. Inspect and record representative-localized repairs.
 - g. Conduct final review of completed coating system installation.
 - h. Prepare and submit site visit reports after each site visit to document that the coating work is in accordance with the CSM's Recommendations.

- D. Final report:
1. Prepare a final report, after coating work ends, summarizing each day's test data, observations, drawings, and photographs. Include substrate conditions, ambient conditions, and application procedures observed during the CTR's site visits. Include a statement that completed work was performed in accordance with the requirements of the CSM's recommendations.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Coating materials shall be formulated for environments encountered in water and wastewater treatment processes.
- B. Coating materials that come in contact with water distributed as potable water shall be certified in accordance with NSF 61.

2.02 MATERIALS

- A. General:
 1. Product requirements as specified in Section 01_60_00 - Product Requirements.

2.03 COATING SYSTEMS IDENTIFICATION

- A. Naming Conventions: Coating Systems Identifications contain the elements defined in Table 1.

Table 1 Coating System Identification Elements						
First Element	-	Second Element	-	Third Element	-	Fourth Element (optional)
3 or 4 alpha characters		1-3 alpha characters		1 number		3 or 4 alpha characters
Coating Type		Substrate		System Number		Additional Substrate or Special Condition
Example: EPX	-	C	-	6	-	BSC

- 1) First element identifies the coating type using the following abbreviations:
 - a) ACR: acrylic.
 - b) CTE: coal tar epoxy.
 - c) ELA: elastomeric acrylic.
 - d) EPU: epoxy-polyurethane.
 - e) EPX: epoxy.
 - f) POL: polyurethane.
 - g) SIL: silicone.
 - h) SILX: siloxane or silane.
 - i) VE: vinyl ester.
- 2) Second element identifies the substrate using the following abbreviations:
 - a) C: concrete or masonry.
 - b) F: concrete flooring.

- c) FRP: fiber-reinforced plastic.
- d) GM: galvanized metal.
- e) M: metal.
- f) PVC: polyvinyl chloride, chlorinated polyvinyl chloride.
- 3) Third element identifies the sequential system number.
 - a) For example, EPX-C-2 is the second standard epoxy coating system for concrete substrates.
- 4) Fourth element is optional and identifies the additional substrate or special condition with the following abbreviations:
 - a) PWS: Potable water service applications (NSF-61 approved).
 - b) BSC: Biogenic sulfide corrosion-resistant applications in wastewater.
 - c) BG: Below grade or buried.
 - d) OZ: Organic zinc primer, epoxy polyurethane system.
 - e) SC: Secondary containment.

2.04 PRODUCTS FOR COATING SYSTEMS

- A. Products: As specified in Attachment B - Coating Detail Sheets.
- B. Cleaning solvents:
 - 1. Requirements for solvent wash, solvent wipe, or cleaner used, including, but not limited to, those used for surface preparation in accordance with SSPC- SP 1:
 - a. Emulsifying type.
 - b. Containing no phosphates.
 - c. Biodegradable.
 - d. Does not damage zinc.
 - e. Compatible with the specified primer.
 - f. Complying with applicable air-quality control board requirements.
 - 2. Use clean white cloths and clean fluids in solvent cleaning.

PART 3 EXECUTION

3.01 GENERAL PROTECTION REQUIREMENTS

- A. Protect adjacent coated surfaces from coatings and damage associated with coating work. Repair damage resulting from inadequate or unsuitable protection.
- B. Use drop cloths and other coverings to protect adjacent surfaces not to be coated against spatter and droppings.
- C. Mask off surfaces of items not to be coated or remove items from area.
- D. Furnish and deploy sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and, in particular, surfaces within storage and preparation areas.
- E. Place coating waste, cloths, and material that may pose a fire hazard in closed metal containers and remove daily from site.

- F. Remove electrical plates, surface hardware, fittings, and fasteners before coating application. Carefully store, clean, and replace items after completing coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finishes.
- G. Erect and maintain protective enclosures in accordance with SSPC- Guide 6.
- H. Protect the following surfaces from abrasive blasting by masking or by other means:
 - 1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
 - 2. Machined surfaces for sliding contact.
 - 3. Surfaces to be assembled against gaskets.
 - 4. Surfaces of shafting where sprockets will be fit.
 - 5. Surfaces of shafting where bearings will be fit.
 - 6. Machined bronze surfaces, including slide gates.
 - 7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used to assemble equipment requiring abrasive blasting.
 - 8. Galvanized items, unless scheduled to be coated.
- I. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by spent abrasive blast media, dust, or dirt entering such equipment.
- J. Schedule cleaning and coating to keep dust and spray from the cleaning process from falling on wet, newly coated surfaces.
 - 1. Whenever possible, coordinate with other trades and complete surface preparation and coating work before installing hardware, hardware accessories, nameplates, data tags, electrical fixtures, and similar uncoated items that will be in contact with coated surfaces. Mask machined surfaces, sprinkler heads, and other small items that will not be coated.
 - 2. After completing coating, reinstall removed items.
 - 3. Disconnect and move equipment adjacent to walls to clean and coat equipment and walls. Replace and reconnect equipment after coating.

3.02 GENERAL SURFACE PREPARATION REQUIREMENTS

- A. Prepare surfaces in accordance with CSM's instructions unless more stringent requirements are specified in this Section.
- B. Coating detail sheets in Attachment B - Coating Detail Sheets include additional surface preparation requirements.
- C. Follow more stringent requirement if information conflicts.
- D. Where required by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before applying a coating.
 - 1. CSA shall coordinate coating inspections.
 - a. Identify coating inspection Hold Points during the pre-installation conference.
 - b. Provide at least 2 days notice before inspection.

2. Contractor shall correct surface defects identified by the inspector at no additional cost to Owner.

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

- A. Identify equipment, ducting, piping, and conduit as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment, Section 40_05_00.03 – Pipe Identification, and Section 26_08_00 – Electrical Testing.
- B. Remove grilles, covers, and access panels for mechanical and electrical system and coat separately.
- C. Prepare and finish coat equipment primed by the manufacturer using specified intermediate and top coats, as applicable, and color selected by the Owner.
- D. Prepare, prime, and coat both insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with material not requiring coating, or with a prefinished coating.
- E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.
- F. Prepare and coat interior surfaces of air ducts and convector and baseboard heating cabinets visible through grilles and louvers with 1 coat of flat black paint to limit of sight line.
- G. Prepare and coat dampers exposed immediately behind louvers, grilles, and convector and baseboard heating cabinets to match face panels.
- H. Prepare and coat exposed conduit and appurtenances occurring in finished areas with color and texture to match adjacent surfaces.
- I. Prepare and coat sides' front, back, and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.
- J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming, and numbering, in accordance with the Contract Documents.

3.04 CLEANING OF NEW AND PREVIOUSLY COATED OR NEW SURFACES

- A. Utilize cleaning agent to remove soluble salts, such as chlorides, from concrete and metal surfaces:
 1. Cleaning agent: Biodegradable non-flammable and containing no VOC.
 2. Manufacturers: The following or equal:
 - a. CHLOR*RID International, Inc.
 - 1) Complete soluble salt removal with steam or warm water cleaning.
 3. Test cleaned surfaces to ensure removal of soluble salts. Carry out additional cleaning as needed.
 4. Complete final surface preparation before applying new coating system in strict accordance with CSM's printed instructions.

3.05 BLAST CLEANING

- A. Surface preparation requirements:
 - 1. Do not reuse spent blast abrasive.
 - 2. Ensure that filter compressed air used for blast cleaning is free of condensed water and oil. Clean moisture traps at least once every 4 hours or more frequently, as required, to prevent moisture from entering the abrasive blasting equipment air supply. Check blast air for moisture and oil after each cleaning in accordance with ASTM D4285.
 - 3. Install oil separators just downstream of compressor discharge valves and at the discharge point of blast pot discharges. Check separators on the same frequency as the moisture traps.
 - 4. Keep regulators, gauges, filters, and separators on compressor air lines to blasting nozzles operational at all times.
 - 5. Install an air dryer or desiccant filter drying unit to dry the compressed air before blast pot connections. Use and maintain the dryer throughout surface preparation work.
 - 6. Use a venturi-type, or other high velocity-type, abrasive blast nozzles supplied with at least 100 pounds per square inch gauge air pressure at the nozzle and enough volume to obtain appropriate blast cleaning production rates and surface cleanliness.
 - 7. Provide airborne particulate evacuation and filtering that meets OSHA safety standards. Maintain optimal visibility both to clean and provide the specified surface profile and to allow inspection of the substrate during surface preparation work.
 - 8. If prepared and cleaned metallic substrates become contaminated between final surface preparation work and coating system application, or if the prepared substrate darkens or changes color, re-clean by water blasting, or abrasive blast cleaning as appropriate until the specified degree of cleanliness is restored.
- B. Water jetting or water blasting:
 - 1. Use water jetting or water blasting for recoating or relining where an adequate surface profile exists.
 - 2. Perform water jetting or water blasting in accordance with SP 13 and SSPC- WJ-1, WJ-2, WJ-3, WJ-4.

3.06 PREPARATION REQUIREMENTS FOR CONCRETE SURFACES

- A. Cure for at least 28 days before coating.
- B. Remove degraded concrete using abrasive blast cleaning or high or ultra-high-pressure water jetting, chipping, or other abrading tools until achieving a sound, clean substrate. Remove all bruised or cracked concrete.
- C. Prepare substrate cracks and areas requiring resurfacing; perform detail treatment, including, but not limited to, terminating edges per the CSM's recommendations and as indicated on the Drawings.
 - 1. Prepare concrete surfaces in accordance with SSPC-SP 13.

- D. Prepare concrete surfaces in accordance with SSPC-SP 13.
 - 1. Inspect concrete surfaces to select appropriate surface preparation method to provide a suitable substrate for the specified coating system.
 - 2. Use blast cleaning or other means to expose the complete perimeter of air voids or bug holes. Do not leave shelled over, hidden air voids beneath the exposed concrete surface.
 - 3. Repair concrete defects and physical damage.
 - 4. Clean concrete surfaces of dust, mortar, formwork, fins, loose concrete particles, form release materials, oil, and grease.
 - 5. Fill voids to provide surface as specified in Section 03_35_29 - Tooled Concrete Finishing.
- E. Provide clean substrate visually free of calcium sulfate, loose, coarse, or fine aggregate, laitance, loose hydrated cement paste, and otherwise harmful substances.
 - 1. Confirm concrete surface minimum pH of 9.0 with surface pH testing.
 - 2. If after surface preparation the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
- F. Prepare concrete surface for coating in accordance with SSPC-SP 13.
 - 1. Provide ICRI 310.2 minimum No. 3 concrete surface profile (CSP) or as specified on Coating Detail Sheets.
 - 2. Evaluate profile of the prepared concrete using ICRI 310.2 surface profile replicas.
- G. Blast clean cementitious repair mortars or grouts to the same profile and degree of cleanliness requirements required for concrete substrates.
- H. Blast clean polymer-based surfacers or waterborne modified cementitious surfaces only if they have exceeded the CSM's recommended recoat time.
- I. Vacuum all concrete surfaces before coating application, leaving a dust free, sound concrete substrate.
 - 1. Thoroughly clean concrete surfaces to be coated to remove loose dirt and spent abrasive.
 - 2. Remove debris produced by blast cleaning from the structures to be coated, and legally dispose of it off-site.
- J. Masonry surfaces:
 - 1. Cure for at least 28 days before coating.
 - 2. Prepare masonry surfaces to remove chalk, laitance, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
 - 3. Wash and scrub masonry surfaces with clear water. Do not use muriatic acid.
 - 4. Seal or fill masonry surfaces with a sealer or block filler compatible with the specified primer after cleaning.

5. Confirm that masonry surfaces are dry before coating application.
 - a. If using pressure washing or low-pressure water blast cleaning for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or until the minimum ambient temperature is 70 degrees Fahrenheit before coating.

3.07 GENERAL PREPARATION REQUIREMENTS FOR METALLIC SURFACES

- A. Remove rust, scale, and welding slag and spatter.
 1. Remove and grind smooth all excessive weld material and weld spatter on metal surfaces before blast cleaning in accordance with NACE SP0178, Appendix C, Level C.
 2. Grind sharp edges on metal substrate to approximately 1/16-inch radius before abrasive blast cleaning.
- B. Prepare metallic surfaces in accordance with applicable portions of surface preparation specifications of the SSPC specified for each coating system.
 1. Remove grease and oil in accordance with SSPC-SP 1.
 2. Use solvent as recommended by the CSM.
 3. Measure profile depth of the surface to be coated in accordance with Method C of ASTM D4417. Contractor shall select blast particle size and gradation to produce the specified surface profile.
 4. Constantly monitor and maintain ambient environmental conditions to ensure cleanliness and that no "rust back" occurs before coating material application.
- C. Prepare metallic surfaces by blast cleaning in accordance with SSPC-VIS 1 (ASTM D2200). Prepare abrasive blast representative areas for the Owner's representative to inspect on the first day of cleaning.
- D. Unless otherwise specified, the requirements for blast cleaning steel, ductile iron, and stainless steel substrates are as follows:
 1. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC-SP 10 unless blasting may damage adjacent surfaces, is prohibited, or is specified otherwise. Where abrasive blasting is not possible, clean surfaces to bare metal with power tools in accordance with SSPC- SP 11.
 2. Ferrous metal surfaces to be submerged: Abrasive blast in accordance with SSPC-SP 5, unless specified otherwise, to clean and provide roughened surface profile with a depth between 2 and 4 mils.
 3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products, or embedded abrasive from substrate before coating application.
 4. When abrasive blasted surfaces rust or discolor before coating, abrasive blast clean surfaces again.
- E. Field preparation of shop-primed surfaces:
 1. Smooth welds and prominences with power tools before applying field-applied coatings.
 2. Clean and dry shop-primed ferrous metal surfaces and fabricated assemblies before applying field coats.

3. Prepare shop epoxy primed surfaces with light abrasive blasting or abrading and then vacuum before applying finish coats.
 - a. Follow CSM instructions for surface preparation when the primer recoat limit has been exceeded.
 4. Non-immersion service: Clean in accordance with SSPC-SP 2 (Hand Tool Cleaning) or SSPC-SP 3 (Power Tool Cleaning) and uniformly roughen.
 5. Immersion, BSC, and SC service: Remove shop primer in accordance with SSPC-SP 5 (Near-White Blast Cleaning).
- F. Damaged shop primer or rust bleeding:
1. Ferrous metals: Clean in accordance with SSPC-SP 1 (Solvent Cleaning) and spot blast in accordance with SSPC-SP 10 (Near-White Metal Blast Cleaning) to achieve a uniform surface profile between 2.0 and 2.5 mils before recoating.
 2. Reject galvanized steel with rust bleeding.
- G. Damaged coating: Repair by abrasive blast cleaning surfaces as specified for the coating system; feather to a smooth transition before touching up.

3.08 PREPARATION REQUIREMENTS BY SURFACE TYPE

- A. Galvanized steel and non-ferrous metal surfaces:
1. Degrease or solvent clean (SSPC-SP 1) to remove oily residue.
 2. Abrasive blast clean in accordance with SSPC-SP 16.
 - a. If abrasive blast cannot be performed, abrade in accordance with SSPC-SP 3 (Power Tool Cleaning).
 3. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded, such as bolts, nuts, or preformed channels.
 4. Test surface for contaminants using copper sulfate solution.
- B. Stainless-steel surfaces:
1. Abrasive blast clean in accordance with SSPC-SP 16 to leave a clean, uniform appearance with surface profile between 1.5 and 2.5 mils.
- C. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.
- D. Sherardized, aluminum, copper, and bronze surfaces:
1. Abrasive blast clean in accordance with SSPC-SP 16.
 2. Prepare in accordance with CSM's instructions.
- E. Cadmium-plated, zinc-plated, or sherardized fasteners:
1. Abrasive blast in the same manner as uncoated metal when assembling equipment designated for abrasive blasting.
- F. PVC and FRP surfaces:
1. Lightly sand surfaces to be coated.
 - a. Sand to remove gloss and establish uniform surface profile.
 2. Vacuum to remove loose dust, dirt, and other materials.
 3. Solvent clean with clean white rags and allow solvent to evaporate completely before applying coating materials.

3.09 APPLICATION REQUIREMENTS

- A. Apply coatings in accordance with manufacturer's instructions.
- B. Empty aboveground piping to be coated of contents when applying coatings.
- C. Mechanical equipment shop primed by the manufacturer.
 - 1. Pumps and valves: Shop coat with manufacturer's highest quality coating system meeting the project specifications.
 - a. Contractor shall provide CTR shop coating reports.
 - 2. Non-immersed equipment: Touch up shop primer, and coat in the field with specified coating system after installation.
 - a. If project requires equipment removal and reinstallation, complete touch-up coating after final installation.
 - 3. Immersed equipment not shop coated: Remove shop primer before surface preparation and field apply coating.
- D. Verify surface preparation immediately before applying coating in accordance with SSPC SP COM and the SSPC visual standard for the specified surface preparation method.
- E. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.
- F. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.
- G. Do not apply coatings to a surface until it has been prepared as specified.
- H. Use equipment designed to apply materials specified.
 - 1. Use compressors with moisture traps and filters that remove water and oils from the air.
 - a. Perform a paper blotter test at the Engineer's request to verify air is sufficiently free of oil and moisture. Do not allow the amount of oil and moisture to exceed CSM-recommended amount.
 - 2. Equip spray equipment with properly sized mechanical agitators, pressure gauges, pressure regulators, and spray nozzles.
- I. Where 2 or more coats are required, tint prime coat intermediate coats as necessary to distinguish each coating and to help indicate coverage.
 - 1. Do not use color additives with chromium, lead or lead compounds that hydrogen sulfide, other corrosive gases, might destroy or alter. Apply the specified number of coats.
- J. Apply coating by brush, roller, trowel, or spray unless a specific application method is required by coating manufacturer's instructions or these Specifications.
 - 1. Apply primer or first coat by brush to power tool cleaned ferrous surfaces.
 - 2. Brush or spray-apply coats for blast-cleaned ferrous surfaces and subsequent coats for non-blast cleaned ferrous surfaces.
 - 3. After prime coat dries, mark, repair, and retest pinholes and holidays before intermediate or top coats are applied.

- K. Spray application:
 - 1. With a brush, stripe coat edges, welds, corners, nuts, bolts, and difficult-to-reach areas, as necessary, before spray application to ensure specified coating thickness along edges.
 - 2. When using spray application, apply each coat to thickness no greater than recommended in coating manufacturer's instructions.
 - 3. Use airless spray method unless air spray method is required by CSM's instruction or these Specifications.
 - 4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.
- L. Lightly sand and thoroughly clean surfaces to receive high-gloss finishes unless CSM instructs otherwise.
- M. Remove all dust on coatings between coats.
- N. Shop and field coats:
 - 1. Prime coat: Shop-apply or field-apply prime coats as specified. Use shop-applied primer compatible with the specified field coating system and apply at the minimum dry film thickness recommended by the finish coat CSM.
 - a. Provide data sheets identifying the shop primer to on-site coating application personnel.
 - b. Perform adhesion tests on the shop primer.
 - c. Remove and recoat damaged, deteriorated, and poorly applied shop coatings.
 - d. If shop primer coat meets this Section's requirements, spot prime exposed metal of shop-primed surfaces before spray applying primer over the entire surface.
 - 2. Field coats: Apply field coats with 1 or more prime coats and finish coats to build up coating to dry film thickness specified for the coating system.
 - a. Do not apply finish coats until other work in the area is complete and previous coats are inspected.
 - 3. Adhesion confirmation: Perform adhesion tests after proper coating cure in accordance with ASTM D3359. Demonstrate that:
 - a. Prime coat adheres to the substrate.
 - b. Coatings adhere to the prime and intermediate coats.
 - 1) Coating 5 mils or more DFT: Achieve adhesion test result of 5A on immersed surfaces and 4A or better on other surfaces.
 - 2) Coating less than 5 mils DFT: Achieve adhesion test results of 5B on immersed surfaces and 4B or better on other surfaces.
- O. Brush, roll, trowel, or spray and back roll coats for concrete and masonry.
- P. Plural component coating application:
 - 1. Premix contents of component drums if required by the CSM each day.
 - 2. Before starting application:
 - a. Verify gauges are working properly.
 - b. Complete ratio checks.
 - c. Sample the mix on plastic sheeting to ensure set time is appropriate and complete.
 - d. Label and retain all spray samples. Submit to Engineer when requested.

Q. Drying and recoating:

1. Provide fans, heating devices, or other means to prevent condensate or dew on substrate surface or between coats and during curing after applying the last coat.
2. Allow each coat to cure or dry thoroughly, in accordance with if required in CSM's printed instructions, before recoating.
3. Use CSM's printed instructions and the requirements specified in this Section to determine minimum required drying time.
 - a. Do not allow excessive drying time or exposure, which may impair bond between coats.
 - b. Recoat all coatings within time limits recommended by CSM.
 - c. If time limits are exceeded, abrasive blast clean and de-gloss clean before applying another coat.
4. If limitations on time between abrasive blasting and coating are not met before attaching components to surfaces that cannot be abrasive blasted, coat components before attachment.
5. Ensure primer and intermediate coats of coating are unscarred and completely integral when applying each succeeding coat.
6. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
7. Leave no holidays. Repair all holidays in accordance with the requirements on pertinent Coating Detail Sheets or as recommended by the CSM.
8. Sand and feather in to a smooth transition and recoat scratched, contaminated, or otherwise damaged coating surfaces so repairs are invisible to the naked eye.

R. Workmanship:

1. Ensure that coated surfaces are free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce a smooth, even film of uniform thickness completely coating corners and crevices.
2. Coat surfaces without drops, overspray, dry spray, excessive runs, ridges, waves, holidays, laps, or brush marks.
3. Remove splatter and droppings after coating work is completed.
4. Evenly apply each coat of material and sharply cut to a line created with masking tape or other suitable materials.
5. Avoid over spraying or spattering paint on surfaces not to be coated. Protect glass, hardware, floors, roofs, vehicles, and other adjacent areas and installations by taping, drop cloths, or other suitable measures.
6. When coating complex steel shapes, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer before overall coating system application.
 - a. Brush apply stripe coat to ensure proper coverage.
 - b. Do not stripe coat with spray or roller.
7. Ensure that finish coat, including repairs, has a uniform color and gloss.

S. Coating properties, mixing, and thinning:

1. Thin prime coat and apply as recommended by the CSM. Thinned coating must comply with prevailing air pollution control regulations.
2. If maximum recoat time is exceeded, prepare surface with solvent washing, light abrasive blasting, or other procedures per CSM's instructions.

3. Allow adequate drying time between coats as instructed by the CSM, adjusted as necessary for the site conditions.
 4. Ensure that coatings, when applied, provide a satisfactory film and a smooth even surface. Lightly sand glossy undercoats to provide a surface suitable for proper application and adhesion of subsequent coats. Thoroughly stir and strain coating materials during application and maintain uniform consistency.
 5. Mix coatings with 2 or more components in accordance with CSM's instructions.
 6. Where necessary to suit conditions of the surface, temperature, weather and method of application, thin the coating per CSM's recommendations.
 - a. Ensure that volatile organic content (VOC) of the thinned coating complies with prevailing air pollution control regulations.
 - b. Thin coatings to only what is necessary to obtain proper application characteristics.
 - c. Use a thinner recommended by the CSM.
- T. Film thickness and continuity:
1. Apply coating to the specified thicknesses.
 - a. Apply additional coats when necessary to achieve specified thicknesses, especially at edges and corners.
 2. Verify WFT of the coating system first coat and after applying each subsequent coat.
 3. Do not allow the minimum thickness at any point to deviate more than 25 percent from the required average.
 4. Do not allow the surface area covered per gallon of coating for various types of surfaces to exceed those recommended by the CSM.
 - a. Provide coating coverage worksheets listing the maximum and minimum coverage for each unit volume of coating for concrete surfaces.
 5. Apply additional coats to achieve the specified dry film thickness if brush or roller application methods cannot achieve the specified film thicknesses per coat.
- U. Protecting coated surfaces:
1. Do not handle, work on, or otherwise disturb coated items until the coating is completely dry and hard.
 2. After installation, recoat shop-coated surfaces with specified coating system as necessary to match surrounding surfaces, and to coordinate with the specified color identification requirements.
- V. Special requirements:
1. Before erection, apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces inaccessible after assembly. Apply final coat after erection.
 2. Coat structural slip-critical connections and high strength bolts and nuts after erection.
 3. Areas damaged during erection:
 - a. Prepare surface for spot repairs as specified for the coating system.
 - b. Recoat with prime coat before applying subsequent coats.
 - c. Touch up surfaces after installation.
 - d. Clean and dry surfaces to be coated at time of application.

4. Coat underside of equipment bases and supports not galvanized with at least 2 coats of primer specified before setting the equipment in place.
5. Coat aluminum in contact with concrete.

3.10 APPLICATION REQUIREMENTS FOR CONCRETE COATING SYSTEMS

- A. Apply filler/surfacer as recommended by CSM to fill bug holes and air voids in concrete or block texture in CMU, leaving a uniformly filled surface that does not produce blowholes or outgassing causing the coating system to pinhole.
 1. Allow filler/surfacers to cure sufficiently before applying prime coat as required by the CSM. Use the CSM-recommended drying time between coats.
- B. Apply surfacer or filler and let dry before coating application.
 1. Use the drying time between filler/surfacer and coating system specified by the CSM for the site conditions.
 - a. Let concrete substrate dry before applying filler/surfacers or coating system materials.
 2. If the maximum recoat time is exceeded, prepare surfaces by solvent washing, light abrasive blasting, and other procedures per CSM's instructions.
 3. Apply a complete parge coat of the specified filler/surfacer material over the entire substrate before applying the coating system.
 - a. Scrub filler/surfacer into the substrate to completely fill open air voids and bug holes.
 - b. Completely cover the substrate, unless otherwise specified, above such filled voids by 1/8 inch of thickness.
 - c. Provide relatively flat, uniformly even surface before coating application.
 4. Secondary containment: Place surfacer or filler 1/16 inch thick above concrete plane to create a monolithic surface free of pinholes.
 - a. Floor surfaces: Broadcast with aggregate to create a non-slip surface texture.
 - b. Remove excess aggregates and apply base coat to encapsulate embedded non-slip aggregate.
- C. Concrete substrate temperatures:
 1. Apply filler/surfacers and the coating system when temperatures are falling, typically late afternoon or evening.
 - a. Do not coat concrete with rising concrete substrate surface temperatures or substrates in direct sunlight, to minimize outgassing from the substrate and formation of pinholes, and/or blistering.
 2. Should bubbles, pinholes, or other discontinuities form in the applied coating system material, they shall be repaired.
 - a. Should discontinuities develop in the filler/surfacer material or in the first coat of the coating material, repair them before the next coat.
 - b. When discontinuities occur, open the air void behind or beneath the discontinuities and completely fill with specified coating material. Then, abrade the coated area around the discontinuities repair reapply coating over that area.
- D. Perform application detail work in accordance with these Specifications, the CSM's current written recommendations, and drawings, whichever is stricter.

- E. Concrete coating systems application requirements:
 - 1. Concrete coating minimum dry film thickness excludes parge coat, block filler, and sealer.

3.11 COATING SYSTEM SCHEDULE

- A. Attachment A - Schedule of Surfaces to be Field Coated specifies surfaces to be coated in the field with the coating systems required.

3.12 SURFACES NOT REQUIRING COATING

- A. Stainless steel piping, valves, pipe supports, instrument sunshades.
- B. Sliding surfaces on expansion joints, motor and pump shafts, machined surfaces at bearings and seals, grease fittings, etc.
- C. Galvanized structural steel framing, galvanized roof decking, galvanized pipe supports.
- D. Copper and brass pipe, fittings, valves, etc.
- E. Bronze valves, bearings, bushings, and fasteners.
- F. Corrosion resistant special alloys: Inconel, Alloy 20, Hastelloy, etc.
- G. Exterior Concrete.
- H. Plastic surfaces except coat PVC, CPVC, and other plastic piping system exposed to sunlight.
- I. Buried Piping that is encased in concrete or cement mortar.

3.13 QUALITY CONTROL

- A. Owner-provided inspection or inspection by others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Owner inspection is in addition to any inspection required of the Contractor.
- B. Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section. These inspections may include the following:
 - 1. Inspect materials upon receipt to ensure that the CSM supplied them.
 - 2. Verify that specified storage conditions for the coating system materials, solvents, and abrasives are provided.
 - 3. Inspect and record findings for substrate cleanliness.
 - 4. Inspect and record pH of concrete and metal substrates.
 - 5. Inspect and record substrate profile (anchor pattern).
 - 6. Measure and record ambient air and substrate temperature.
 - 7. Measure and record relative humidity.
 - 8. Check for substrate moisture in concrete.

9. Verify that mixing of coating system materials is in accordance with CSM's instructions.
 10. Inspect, confirm, and record that coating system materials' "pot life" is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
 11. Perform adhesion testing.
 12. Measure and record the coating system's thickness.
 13. Verify proper curing of the coating system in accordance with the CSM's instructions.
 14. Holiday or continuity testing in accordance with NACE SP0188 for coatings that will be immersed or exposed to aggressively corrosive conditions.
- C. Contractor shall perform holiday testing in accordance with NACE SP0188 to identify holidays or pinholes needing repair for coating over 100 percent of surfaces:
1. Coated steel that will be immersed or exposed to aggressively corrosive conditions.
 2. Coated concrete.
 3. Perform holiday tests after proper application and coating system cure.

3.14 CORRECTIVE MEASURES

- A. Repair pinholes or holidays identified by Holiday Testing as follows:
1. Remove the coating system with a grinder or other suitable power tool.
 2. Remove coating system at all pinholes and holidays at least 2 inches diameter around the defect back to expose substrate.
 3. Concrete voids: chip back to expose entire cavity in all directions.
 - a. Completely fill void with approved filler/surfacer material using a putty knife or other suitable tool and strike off. Cure per CSM's recommendations.
 4. Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
 5. Vacuum the prepared area to remove all dust, dirt, etc., leaving clean, sound surfaces.
 6. Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
 7. Apply the coating system with enough coats to achieve the specified finish coat thickness over the defect and coating removal area. Feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline.
 8. Follow curing time between coats as specified by CSM for the site conditions. Solvent wash and abrasive blast per CSM's instructions, if the maximum recoat time is exceeded.
 9. Apply coating at specified dry film thickness.

3.15 CLEANUP

- A. Remove surplus materials, protective coverings, and accumulated rubbish after completing coating. Thoroughly clean surfaces and repair overspray or other coating-related damage.

3.16 FINAL INSPECTION

- A. Conduct final inspection of coating system work to determine whether it meets specifications requirements.
- B. Conduct subsequent final inspection with Engineer to ensure work conforms to contract documents requirements.
- C. Mark any rework required.
 - 1. Re-clean and repair, as specified, at no additional cost to the Owner.

END OF SECTION

ATTACHMENT A – SCHEDULE OF SURFACES TO BE COATED

APPENDIX A
Schedule of Surfaces to be Coated

- A. The following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Contact Engineer for clarification.

EPU-M-1	Metals, exterior, non-immersed
EPX-M-2	Metals, interior, non-immersed
EPX-M-2-PWS	Metals: immersed and in contact with water being treated for domestic use (potable water).
EPX-M-5	Aluminum surfaces in contact with concrete or masonry. Locations where Alkali-resistant bitumastic is specified.
EPX-M-6-BG	Metals, below grade or buried pipes, valves, pits/chambers
EPU-FRP-1	FRP, exterior of tanks, ducts, pipes
ACR-PVC-1	PVC and CPVC, interior or exterior and FRP, interior
Notes:	
1: Non-immersed ferrous metal surfaces include: a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing. b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports. c. Motors and motor accessory equipment. d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment. e. Valve and gate operators and stands. f. Structural steel. g. Crane and hoist rails. h. Exterior of tanks and other containment vessels. i. Mechanical equipment supports, drive units, and accessories. j. Bare electrical equipment: boxes, exposed conduit, and accessories. k. Pumps not submerged. l. Other miscellaneous metals. 2: Immersed ferrous metal surfaces include: a. Interior surfaces of ferrous metal tanks. b. Field priming of ferrous metal surfaces with defective shop-prime coat; including non-submerged service. c. Bell rings, underside of manhole covers and frames. d. Sump pumps, including underside of base plates and submerged suction and discharge piping. e. Exterior of submerged piping and valves other than stainless steel or PVC piping. f. Submerged pipe supports and hangers. g. Stem guides. h. Other submerged iron and steel metal unless specified otherwise.	

ATTACHMENT B – COATING DETAIL SHEET

Appendix B			
Coating Detail Sheet			
Coating System	EPU-M-1		
Coating Material	Two coats epoxy with polyurethane finish coat		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carbothane 134 VOC
International Paint	Devran 224V	Devran 224V	Devthane 379
PPG	Amercoat 385	Amercoat 385	Amercoat 450H
Sherwin Williams	Macropoxy 646	Macropoxy 646	Hi Solids Polyurethane
Tnemec	Series 69	Series 69	Series 1095
Service Condition	Interior or Exterior, subject to direct sunlight. Non-immersion.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP10, Near-White Blast Cleaning. Shop primed surfaces: SSPC-SP2, Hand Tool Cleaning or SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP10, Near White Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush Blast Cleaning. Test for surface contaminants.		
Surface profile			
Ferrous Metal	2.5 to 3.0 mils		
Nonferrous Metal	1.5 to 2.0 mils		
Galvanized Metal	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	10 to 13 mils		
Primer	4 to 5 mils		
Intermediate Coat	4 to 5 mils		
Finish Coat	2 to 3 mils		
Application			
Special CTR Training	Not required.		

Appendix B			
Coating Detail Sheet			
Coating System	ACR-PVC-1		
Coating Material	Acrylic		
Substrate	PVC and CPVC pipe		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carbocrylic 120	None Applied	Carbocrylic 3359
International Paint	Devcryl 1440	None Applied	Devcryl 1448
PPG	Pitt Tech Primer	None Applied	Pitt Tech
Sherwin Williams	Sher Cryl HPA	None Applied	Sher Cryl HPA
Tnemec	Series 1028 or 1029	None Applied	Series 1028 or 1029
Service Condition	Exterior, exposed to direct sunlight, non-immersed.		
Surface Preparation	Prepare surfaces as specified in this Section and as follows.		
General	Clean to remove loose dirt, dust, or other contaminants. Sand surfaces to achieve a uniform, roughened surface profile. Solvent clean and vacuum to remove loose debris.		
Surface profile	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	4 to 8 mils		
Primer	2 to 4 mils		
Finish Coat	2 to 4 mils		
Application			
Special CTR Training	Not Required.		

SECTION 10_71_18
SHADE STRUCTURE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Work associated with the shade structure, including structure, shade panels, supports, and other related work indicated on the Drawings and as specified in this Section.
- B. The Contractor shall engineer a shade structure with parameters as specified in this Section.
- C. The Contractor shall furnish and install shade for areas as indicated on the Drawings.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 2. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 3. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

1.03 SUBMITTALS

- A. The Engineer shall submit the following:
 - 1. Catalog sheets and technical information for structural material.
 - 2. Connection details.
 - 3. Welding details.
 - 4. Assembly drawings.
 - 5. Structural drawings sealed and signed by a structural engineer having a current engineering registration in the State where the project is located.
 - a. Calculations shall include the structure, shade panels, and anchorage.
 - 6. Paint selection.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Comply with the requirements of the building code specified in Section 01_41_00 - Regulatory Requirements.

- B. Design and fabricate shade structure for resistance to the following loads as specified in Section 01_81_50 - Design Criteria:
 - 1. Wind loading: Minimum wind pressure for components and cladding, strength level:
 - a. Wall elements: Minimum 86 pounds per square foot, pressure or vacuum.
 - b. Roof elements: Minimum 195 pounds per square foot, pressure or vacuum.
 - c. For "allowable stress level" pressures, multiply strength level pressures by 0.625.

2.02 STRUCTURE

- A. The structure shall be made of 6- by 6-inch 16-gauge (minimum) steel tubes.
- B. All corners and perpendicular connections shall be braced with 6- by 6-inch 16-gauge steel tubes.
- C. All connection shall be welded unless noted otherwise.
- D. Shade structure shall be removable using detachable pedestal plates.
- E. Minimum roof slope shall be 1 vertical to 12 horizontal.
- F. Shade structure shall be primed and coated as specified in Section 09_96_01 – High-Performance Coating.
- G. Paint color shall be selected by Owner during construction.
- H. Erection hardware:
 - 1. Bolt and fastening hardware shall be determined based on calculated engineering loads.
 - 2. Specifications, based on the following load requirements are:
 - a. Low strength: ASTM F593 stainless steel bolts, nuts, and washers.
 - b. Medium strength: ASTM A307 zinc-plated steel bolts, nuts, and washers.
 - c. High strength: ASTM F3125, Grade A325 zinc-plated steel bolts, nuts, and washers.
- I. Manufacturers: One of the following or equal:
 - 1. Tropical Awnings and Shutters.
 - 2. Tropical Awning of Florida.
 - 3. Florida Playgrounds & Shade.
 - 4. Sun Ports International, Inc.

2.03 SHADE PANELS

- A. Design and performance criteria
 - 1. Design and size components to withstand dead and live loads as calculated in accordance with the Building Code as specified in Section 01_41_00 - Regulatory Requirements.

2. Maximum allowable deflection:
 - a. Wall panel: 1/180.
 - b. Roof panel: 1/240.
3. 36" PBR roof panel 22 gauge minimum, Galvalume plus finish.
4. Color shall be selected by Owner during construction.

2.04 SHADE STRUCTURE DIMENSIONS

- A. Shade structure size and roof slope shall be as indicated on the Drawings.
- B. Contractor shall field measure and verify equipment size prior to starting to manufacture the shade structure. If equipment provided is larger than indicated on the Drawings, structure size shall be adjusted to provide full shade at the equipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Shade structure shall be installed by the manufacturer.
- B. The shade structure shall be installed as indicated on the Drawings.

END OF SECTION

SECTION 26_05_02

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

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

1.02 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.

1.03 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. Florida Electrical Code.
 - 5. State Fire Marshal.
 - 6. Underwriters' Laboratories (UL).
 - 7. National Electrical Safety Code (NESC).
 - 8. American National Standards Institute (ANSI).
 - 9. National Electrical Manufacturer's Association (NEMA).
 - 10. National Electrical CONTRACTOR'S Association (NECA) Standard of Installation.
 - 11. Institute of Electrical and Electronics Engineers (IEEE).
 - 12. Insulated Cable Engineers Association (ICEA).
 - 13. Occupational Safety and Health Act (OSHA).
 - 14. National Electrical Testing Association (NETA).
 - 15. American Society for Testing and Materials (ASTM).
 - 16. Florida Building Code, including local 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.

1.04 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 and supporting raceway for future equipment.
 - 2. Provide and install all electrical equipment indicated on the drawings and described in the specifications including circuit breaker, panelboards, disconnects, local starters, wire, raceway, etc. complete in place.
 - 3. Provide and install new lightning protection and grounding systems 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.
 - 5. After approval of the instrumentation submittal and most of the package systems, the electrical contractor shall arrange a meeting with the electrical engineer and verify that all power, control and instrumentation signals are present in a designated conduit.
- 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.

1.05 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 26, Electrical sections.
 - 6. As part of the electrical submittal, the contractor shall provide a minimum of 1/4"=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 all electrical equipment:
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.
 2. 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.
 3. 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 1/4"=1'-0".
 4. 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.

1.06 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.

1.07 INSPECTION OF THE SITE AND EXISTING CONDITIONS

- A. 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.

1.08 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 that affect the work covered under Division 26, 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.
 - 4. Coordinate with equipment supplier for dimensions of the equipment and ask the supplier to ship the equipment in section if the equipment is too large to enter the room (door) where the equipment will be installed. The cost to assembly the equipment at the job site shall be included in the bid price.

1.09 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 (Cutler-Hammer). 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.
- 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 START-UP

- 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. Start-Up:
1. Demonstrate satisfactory operation of all 480-volt electrical equipment.
Participate with other trades in all start-up activities.
 2. Assist the Instrumentation and Control (I&C) Contractor in verifying signal integrity of all control and instrumentation signals.

END OF SECTION

SECTION 26_05_04

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards 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):
 - a. 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):
 - a. 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. F486E - 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.
- B. Quality Control Submittals:
 - 1. Test Report: Sound test certification for dry type power transformers (0 to 600-volt, primary).

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 3.02 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 304 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, ACtype, 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 one-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 25,000 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 one 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. Schneider Electric
 2. Eaton Electrical.
 3. 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, two above and two 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 Celsius 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 one-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 multipole circuit breakers are shown.

2.08 FUSED 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 Celsius 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 NONFUSED 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 Celsius 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, 0- 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.
- 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 two lines, as required, indicating specific function.
 - 3. Letter Height: 7/64 inch.
- G. Manufacturers:
 - 1. Heavy-Duty, Oiltight Type:
 - a. General Electric; Type CR 104P.
 - b. Square D; Type T.
 - c. Cutler-Hammer; Type 10250T.
 - 2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
 - a. Square D; Type SK.
 - b. General Electric; Type CR 104P.
 - c. Cutler-Hammer; Type E34.
 - d. Crouse-Hinds; Type NCS.

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 allowing use of preprinted or field-marked tags.

- J. Manufacturers:
 - 1. Weidmuller.
 - 2. Ideal.
 - 3. Electrovert.

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. Cutler-Hammer; 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: Two-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. Schneider Electric
 - 2. Eaton Electrical.
 - 3. Approved equal.

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. Schneider Electric.
 - 2. Eaton Electrical.
 - 3. 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, two-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 three-phase units 3 to 15 kVA.
 2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.
- 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 three-phase units, 15 to 30 kVA.
- G. Voltage Taps:
1. Single-Phase, 3 to 10 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
 2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
 3. Three-Phase, 3 to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
 4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two 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. Eaton Electrical.
 2. Square D.
 3. 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 1 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

- A. Material: Laminated plastic.
- B. Attachment Screws: Stainless steel.
- C. Color: White, engraved to a black core.
- D. Engraving:
 - 1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
 - 2. Panelboards: Panelboard designation, service voltage, and phases.
- E. Letter Height:
 - 1. Pushbuttons/Selector Switches: 1/8 inch.
 - 2. Panelboards: 1/4 inch.

2.25 SURGE PROTECTIVE DEVICES

- A. This section describes the material and installation requirements surge protective 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 | 400V |
| 480Y/277 | 800V | 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. Square D.
 3. Approved equal.

2.26 CORRUGATED SWITCHBOARD NON-CONDUCTIVE MATS

A. Specification:

1. Usage - Around electronic and high-voltage apparatus.
2. Compound - 1/4-inch Vinyl.
3. ANSI/ASTM Rating - D178-01 - Type II - Class 2.
4. Dielectric Breakdown - ASTM DI49-97a (Minimum 30,000 V): PASS.
5. Coefficient of Friction - 0.91 Dry per ASTM F1677.
6. Tabor Abrasion - 1 percent lost at 1,000 cycles per Fed. Std. 191.
7. Flammability - "A" Rating per MVSS 302.
8. Flame Resistance - ASTM D178-01: 0.224 mm/s.
9. Accelerated Aging - ASTM D573-88: 1000 psi.
10. Electric Proof Test - ASTM D178-01 (Minimum 20,000 V - 1 min): PASS.
11. Elongation - ASTM D412-98a Die C: 300 percent.
12. Moisture Absorption - ASTM D570-95: 0.2 percent.
13. O3 Resistance Test: Method B - ASTM D178-01: PASS.
14. Oil Resistance - ASTM D471-97: 2.0 percent.
15. Tensile Strength - ASTM D412-98a Die C: 1212 psi.
16. Tension Set - ASTM D412-98a Die B: 0.228 in.

PART 3 EXECUTION

3.01 GENERAL

- A. Install equipment in accordance with NECA 5055.

3.02 INSULATION MATS INSTALLATION

- A. Provide and install corrugated insulation mats in front of all electrical equipment (transformers, switchgears, MCCs, panelboards, etc.) to protect personnel from electrocution.

3.03 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. Exposed EMT: Sheet steel.
 - c. Concealed Raceways: Sheet steel.
 - d. Concrete Encased Raceways: Cast metal.
 - e. Lighting Circuits, Ceiling: Sheet steel.
 - f. 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.

3.04 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 three 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.

3.05 TELEPHONE TERMINAL CABINET (TTC)

- A. Not applicable.

3.06 TELEPHONE OUTLET

- A. Not applicable.

3.07 WIRING DEVICES

- A. Switches:
 - 1. Mounting Height: See Article 3.02 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, three-wire supply is shown.

3.08 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.

3.09 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.

3.10 TERMINAL JUNCTION BOX

- A. Install in accordance with Article 3.03 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.

3.11 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.

3.12 INDUSTRIAL CAPACITORS

- A. Provide suitable hangers or mounting brackets for wall or ceiling mounting.

3.13 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 moisture proof, 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 three-phase units, 15 to 112 kVA.

3.14 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.

3.15 MOTOR SURGE PROTECTION

- A. Ground in accordance with NFPA 70.
- B. Low Voltage: Ground terminals to equipment bus.

END OF SECTION

SECTION 26_05_05

CONDUCTORS

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. 386 - Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
 2. 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.
 3. Association of Edison Illuminating Companies (AEIC):
 - a. CS 5 - Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.
 - b. CS 6 - Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.
 4. Insulated Cable Engineer's Association, Inc. (ICEA):
 - a. T-29-250 - Procedure for Conducting Vertical Cable Tray Flame Test With a Theoretical Heat Input of 210,000 Btu/hour.
 5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 48 - Standard Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations.
 - b. 404 - Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.
 6. National Electrical Contractors Association, Inc. (NECA):
 - a. 5055 - Standard of Installation.
 7. National Electrical Manufacturers' Association (NEMA):
 - a. CC 1 - Electric Power Connectors for Substations.
 - b. WC 3 - Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - c. WC 5 - Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - d. WC 7 - Crosslinked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - e. WC 8 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - f. WC 55 - Instrumentation Cables and Thermocouple Wire.

8. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code (NEC).
9. 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. 486B - Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
 - f. 510 - Standard for Safety Insulating Tape.
 - g. 854 - Standard for Safety Service-Entrance Cables.
 - h. 910 - Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
 - i. 1072 - Standard for Safety Medium-Voltage Power Cables.
 - j. 1277 - Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - k. 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.
 3. Cable fault detection system descriptive product information.
 4. Manufactured wiring systems descriptive product information.
 5. Manufactured wire systems rating information.
 6. Manufactured wire systems dimensional drawings.
 7. Manufactured wire systems special fittings.
 8. Busway descriptive product information.
 9. Busway rating information.
 10. Busway dimensional drawings.
 11. Busway special fitting information.
 12. Busway-equipment interface information for equipment to be connected to busways.
- 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. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Stranded copper.
 - 2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.
 - 3. All Other Circuits: Stranded copper.
- C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.
- 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 megger 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:

Number of Conductors	Maximum Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
 - a. Okonite Co.
 - b. Rome Cable.

D. Type 2-Multiconductor Power Cable:

1. Conductors:
 - a. Class B stranded, coated copper.
 - b. Insulation: Chemically crosslinked ethylene-propylene with Hypalon jacket.
 - c. UL 1581 listed as Type EPR, rated VW-1.
 - d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article 3.02 POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.
2. Cable pass the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	Number of Conductors	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2	0.42	45
		3	0.45	45
		4	0.49	45
10	10	2	0.54	60
		3	0.58	60
		4	0.63	60
8	10	3	0.66	60
		4	0.72	
6	8	3	0.74	60
		4	0.81	

Conductor Size	Minimum Ground Wire Size	Number of Conductors	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
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. Pome Cable.

- 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.
 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.
 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 value.
 - b. Insulation resistance tests shall be performed by using a 500 volt megohmmeter 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.
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 white.
 5. Manufacturers:
 - a. Okonite Co.
 - b. Alpha Wire Corp.
- 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.
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.

- H. Alpha Wire Corp. 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.

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.

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 MC 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 XHHW or RHW rated 75 degrees C 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 aluminum armor and overall polymeric jacket.
 - f. Armor must be continuous corrugated aluminum armor (CCA) manufacture. Aluminum interlocked armor (AIA) construction is not acceptable.

3. Each ground conductor size (circular mil area) shall be one-third (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 used. 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 – ARMOR-X.
 - b. 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 degrees C to +75 degrees C. Model Number – 7881A, Belden Inc.
 3. NEC/UL specification CMR, UL444, UL verified category 6.
 4. Manufacturer: Belden Inc.

2.03 FIBER OPTIC CABLE AND ACCESSORIES

- A. Fiber Optic Cable:
1. Fiber Characteristics: Single-Mode.
 - a. Comply with TIA/EIA 568.
 - b. 8.3/125 µm glass single-mode.
 - c. Tight-buffered, 900 µm buffer:
 - 1) Inner buffer: Acrylate, UV-cured, soft.
 - 2) Outer buffer: PVC, elastomeric, hard.
 - d. Maximum Attenuation: Inside Plant 1,310/1,550 nm: 1 dB/km. Outside Plant 1,310/1,550 nm: **0.35/0.2** dB/km.
 - e. Color-coded buffer.
 - f. Minimum Bend Radius, Buffered Fiber: 1 inch.
 - g. Proof Testing: 100 kpsi.
 - h. Riser or plenum rated cable shall be used for all interior installations.
 2. Fiber Characteristics: Multimode OM3:
 - a. Comply with TIA/EIA 598.
 - b. 50/125 µm graded-index corning glass.
 - c. Tight-Buffered, 900 µm buffer:
 - 1) Inner buffer: Acrylate, UV-cured, soft.
 - 2) Outer buffer: PVC, elastomeric, hard.
 - d. Maximum Attenuation:
 - 1) 850 nm: 2.3 dB/km.
 - 2) 1300 nm: 0.6 dB/km.
 - e. Minimum Bandwidth:
 - 1) 850 nm: 700 MHz-km.
 - 2) 1300nm: 500 MHz-km.
 - f. Color-coded buffer.
 - g. Minimum Bend Radius, Buffered Fiber: 1 inch.

- h. Proof Testing: 100 kpsi.
- i. Plenum rated cable shall be used for all interior installations.
- 3. Cable:
 - a. Fiber Count:
 - 1) Single-mode: 12 fibers per cable, minimum.
 - 2) Multimode: 12 fibers per cable, minimum.
 - b. All Dielectric Construction: No electrically conductive components in fiber optic cable are allowed.
 - c. Helically Wound: Buffered fibers helically wound; approximately 5 turns per meter.
 - d. Gel-Free: Fibers tight-buffered, not in gel-filled loose-tube.
 - e. Core-Locked with no separator tape.
 - f. Style: Provide breakout type of cables where neither a fiber distribution frame or fiber center are provided for termination of all fibers.
 - g. Strength Member:
 - 1) Nonconductive; integral part of cable; supports stress of installation and load during use.
 - 2) Fiberglass epoxy rod, aramid fiber, kevlar.
 - h. Minimum Bend Radius:
 - 1) Short-term Under Tension: 20 times cable diameter.
 - 2) Long-term Without Tension: 15 times cable diameter.
 - i. Identification:
 - 1) Identify with tags shown and in accordance with Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
 - 2) Use waterproof tags and identifications.
 - j. Special Features: Cables to be installed in accordance with NEC Article 770 and other applicable codes. Cable supplier is responsible for selecting cable types, including appropriate plenum/riser ratings, required for compliant installation.
 - k. Manufacturer: Corning.

B. Innerduct:

- 1. Function: Installs into conduit system provided by others, to provide smooth, low-friction path through conduit, with only one cable per path to facilitate changing individual cables.
- 2. Features:
 - a. Size and Count, in 4-inch conduit: 32 mm; 3.
 - b. Type: Annular, corrugated innerduct.
 - c. Material: HDPE.
 - d. Color: Color code in innerducts Orange, Blue, Green, Brown, White, or Grey.
 - e. Strength: Minimum 600 pounds tensile strength, with no more than 5 percent ovalization at 600 pounds tension.
 - f. Lubrication: Prelubricated.
- 3. Manufacturers:
 - a. Endocor.
 - b. Dura-Line.

- C. Fiber Distribution Frame:
1. Function: Provides industry-standard rack mounting system for interface between fiber optic backbone and equipment cables.
 2. Features:
 - a. Used in either cross-connect or interconnect configuration.
 - b. 23-inch rack for mounting 19-inch rack mount units.
 - 1) Accommodates up to 576 fiber terminations per frame.
 - 2) Accepts connector module housing and splice housing within same rack.
 - c. Fiber/Wire Management System:
 - 1) Vertical: 3-inch by 4-inch supports on 8-inch centers vertically on four sides (front LHS, back LHS, front RHS, back RHS).
 - 2) Horizontal: Supports on 4-inch centers horizontally above and below each termination frame front and back. Support may serve frames immediately above and below.
 - d. Mounting Hardware: Accepts standard 19-inch rack for integrated fiber optic system (i.e. hubs, routers, patch panels, etc.).
 - e. Splice Trays with Coil Former: Former to wind slack cable around, provides controlled long radius bends.
 - 1) Doors: Pivot down lockable.
 - 2) Foot and End Caps: Included in final, assembled unit.
 - 3) Ancillaries: Jumper troughs and covers, cable tie brackets.
 3. Manufacturers:
 - a. Ortronics.
- D. Fiber Centers (Patch Panels):
1. Function: Provides a secure place to terminate fiber optic cables.
 2. Features:
 - a. Compartments: Two; one for fiber optic cable, one for jumpers to individual equipment.
 - b. Coil Former: Former to wind slack cable. Provides controlled long-radius bends.
 - c. Connectors: Minimum 24 connectors for entry and exit.
 - d. Size: Maximum 18 inches by 12 inches by 4 inches.
 - e. Construction: 1.5-millimeter steel with noncorrosive finish.
 - f. Mountings: Suitable for permanent attachment as shown, or provide separate mountings that do not obscure covers and doors.
 - g. Doors: Required
 3. Manufacturers and Products:
 - a. Ortronics; OR-615SMFC.
 - b. AT&T.
- E. Connectors:
1. Features:
 - a. In accordance with requirements of TIA/EIA 568, Section 12.4.3 or Annex F.
 - b. Pull Strength: 0.2 N minimum.
 - c. Durability: Sustain minimum 500 mating cycles without violating other requirements.
 - 1) Ferrules: Free-floating low loss ceramic.

- 2) Polarizing key on duplex connector systems.
 - d. Quantity: Connectorize all fibers on cables.
 - 2. Attenuation:
 - a. In accordance with requirements of TIA/EIA 568, Section 12.4.4.
 - b. Maximum of 0.75 dB per connector pair.
 - 3. Manufacturer: AMP.
- F. Jumper Cables:
- 1. In accordance with requirements of TIA/EIA 568, Section 12.5.
 - 2. Function: To connect from fiber centers to network nodes, such as computer workstations.
 - 3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
 - 4. Cable Configuration:
 - a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
 - b. Protected with kevlar strength members and enclosed in thermoplastic jacket.
 - 5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
 - 6. Connectors:
 - a. As required by Article Connectors.
 - b. On-axial Pull Strength: 33 N.
 - c. Normal-to-Axial Pull Strength: 22 N.
 - 7. Communications Management Outlets:
 - a. In accordance with TIA/EIA 568, Section 12.4.5.
 - b. Function: Provide organized system for connecting workstations into precabled communications.
 - c. Cover Plates:
 - 1) Flush and extension mount, as required to provide bend radius and space for coiled cable.
 - 2) Materials: ABS plastic.
 - 3) Color: White, unless otherwise indicated.
 - 4) Identifiers: Color-coded identification strips.
 - d. Manufacturers and Products:
 - 1) Ortronics; Series II.
 - 2) AMP; Fixed Shroud Duplex (FSD) System.

2.04 GROUNDING CONDUCTORS

- A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.
- B. Direct Buried: Bare tinned stranded copper (BTC).

2.05 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) Plytmount; 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.

2.06 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.

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 manholes, hand holes, vaults, 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.
- B. Conductors Above 600 Volts: 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.
1. Colors:
 - a. Grounded Neutral: White.
 - b. Phase A: Brown.
 - c. Phase B: Orange.
 - d. Phase C: Yellow.

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 in lighting and receptacle circuits.
- B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by Engineer.
- C. 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.

- D. Do not use soldered mechanical joints.
- E. Splices and Terminations:
 - 1. Indoors: Use general purpose, flame retardant tape.
 - 2. Outdoors: Use flame retardant, cold- and weather-resistant tape.
- F. Cap spare conductors and conductors with UL listed end caps.
- G. Cabinets, Panels, and Motor Control Centers:
 - 1. Remove surplus wire, braid and secure.
 - 2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
- H. Control and Instrumentation Wiring:
 - 1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
 - 2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
 - 3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
 - 4. Where connections of cables installed under this section are to be made under Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems, leave pigtails of adequate length for bundled connections.
 - 5. 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.
- I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.
- J. 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.

3.05 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 15 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.

3.06 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.

3.07 FIBER OPTIC CABLE AND ACCESSORIES

- A. Ensure that installed conduit system conforms to fiber optic system requirements, including:
 - 1. Conduits and Innerducts: Size and number.
 - 2. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables and innerducts can be installed without exceeding manufacturer's limitations.
 - 3. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
- B. Spare Conduits:
 - 1. No cables shall be pulled into spare conduits.
 - 2. Spare conduits need not have innerduct installed.
 - 3. Expansion Plugs: Seal conduits to stop ingress of water and grit with fabricated expansion plugs.
- C. Innerduct:
 - 1. Installation:
 - a. In accordance with manufacturer's recommendations.
 - b. In all FOCS fiber optic conduits.
 - c. Color Code: Install no more than one innerduct of each color in single conduit.
 - d. Terminations: Terminate innerducts in conduit with fabricated termination kits.

2. Sealing Cabled Innerducts: Seal cables into innerducts to stop ingress of water and grit with fabricated expansion seals that have separate seals for each cable.
 - a. Empty Innerducts: Seal empty innerducts immediately after installation to stop ingress of water and grit with fabricated expansion plugs. Remove plugs as required to install cables.
 - b. Innerduct to Conduit: Seal gaps between innerducts and conduit with sealing compound such as 3M Ductseal.
 3. Identification: Identify innerducts at both ends by methods such as color-coding or waterproof tags wired through innerduct wall.
- D. Fiber Optic Cable:
1. Electrical subcontractor responsibilities include:
 - a. Furnish and install conduit/innerducts.
 - b. Provide estimates of fiber cable lengths based on actual field installation.
 - c. Cable Installation:
 - 1) Install cables in accordance with manufacturer's requirements.
 - 2) Install cable directly from shipping reels. Ensure that cable is not:
 - a) Dented, nicked, or kinked.
 - b) Subjected to pull stress greater, or bend radius less, than manufacturer's specification.
 - c) Subjected to treatment that may damage fiber strands during installation.
 - 3) Provide six (6) feet spare length on each end when pulling fiber optic cable.
 2. PICS supplier responsibilities include:
 - a. Test cable on reels before installation.
 - b. Test cables for damage during installation.
 - c. Terminate cables.
 - d. Test cables after termination.
 3. Cables per Conduit or Innerduct: In accordance with NEC conduit fill limitations.
 4. If calculation indicates that cable will attenuate signals more than 8 dB, reroute may be allowed, if approved by Engineer.
 5. Splices: Install fiber optic cables in unspliced lengths from fiber centers to switches or hubs.
 6. Identification: Identify cable on both ends and in access holes and pull points it goes through.
 7. Sealing: Seal cables into innerducts to stop ingress of water and grit with fabricated expansion plugs.
 8. Access Holes:
 - a. Provide supports for cables in access and handholes at minimum 600 mm centers along sides.
 - b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.
- E. Fiber Centers:
1. Install securely in field panels as shown.
 2. Minimum, one per facility having one or more network nodes.

- F. Cable Terminations:
 - 1. Terminate cables in accordance with TIA/EIA 568.
 - 2. Slack:
 - a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
 - b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
 - 3. Connectors: Terminate 100 percent fibers in each cable to specified connectors.
- G. Ethernet Fiber-to-Copper Transceivers:
 - 1. Install transceivers in accordance with manufacturer's instructions.
 - 2. Location: Install transceivers securely in field panels, close to network nodes and fiber centers.
 - 3. Power: Energize each transceiver from its field panel's UPS, if applicable.
 - 4. Connections:
 - a. Connect transceiver to fiber optics and network node.
- H. Lace fiber optics neatly in place, routed through wireways.
- I. Test and Inspection
 - 1. In accordance with Section 40_08_01 – Commissioning for Instrumentation and Controls.
 - 2. Conduit:
 - a. Testing and Sealing of Spare Conduits.
 - b. Conduit and Innerduct Testing:
 - 1) Blow full-diameter mouse through each spare conduit and innerduct to verify they are unrestricted over full length.
 - 2) If any conduit is not unrestricted over full length, advise Engineer.
 - c. Documentation: Confirm that conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.
 - 3. Cable Testing:
 - a. TIA/EIA 568: Demonstrate that 95 percent of the fibers in each cable meet requirements of TIA/EIA 568.
 - b. Measure attenuation in both directions, not in one direction only.
 - c. For multimode fibers only: Measure attenuation at both 850 nm and 1,300 nm.
 - d. Replace and retest cables that do not have specified number of fibers that meet attenuation standards.
 - e. The following specific testing is required:
 - 1) Test cables onsite post delivery.
 - 2) Test cables following installation.
 - 3) Test cables following termination.
 - f. Test data communication for each link between nodes in the system.

3.08 FIELD QUALITY CONTROL

- A. In accordance Section 26_08_00 - Electrical Testing.

END OF SECTION

SECTION 26_05_26

GROUNDING

PART 1 GENERAL

1.01 REFERENCES

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

1.02 SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data:
 - a. Exothermic weld connectors.
 - b. Mechanical connectors.

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 GROUND ROD

- A. Material: Copper clad.
- B. Diameter: 5/8 inch.
- C. Length: 20 feet.

2.02 GROUND CONDUCTORS

- A. As specified in Section 26_05_05 - Conductors.

2.03 CONNECTORS

- A. Exothermic Weld Type:
 - 1. Outdoor Weld: Suitable for exposure to elements or direct burial.
 - 2. Indoor Weld: Utilize low-smoke, low-emission process.
 - 3. Manufacturers:
 - a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
 - b. Thermoweld.

- B. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
 - 1. Manufacturers:
 - a. Burndy Corp.
 - b. Thomas and Betts Co.

2.04 GROUNDING WELLS

- A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.
- B. Manufacturers:
 - 1. Christy Co.; No. G5.
 - 2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.01 GENERAL

- A. Grounding shall be in compliance with NFPA 70 and ANSI C2.
- B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes using minimum 4/O wire size.
- C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.
- D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
- E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.
- F. Shielded Control Cables:
 - 1. Ground shield to ground bus at power supply for analog signal.
 - 2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
 - 3. Do not ground control cable shield at more than one point.

3.02 WIRE CONNECTIONS

- A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.
- B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to non current-carrying grounding bus.
- C. Connect ground conductors to raceway grounding bushings.

- D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.
- E. Connect enclosure of equipment containing ground bus to that bus.
- F. Bolt connections to equipment ground bus.
- G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.
- H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

- A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.
- B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to non current-carrying grounding bus.
- C. Motors Less Than 10 hp: Furnish mechanical-type terminal connected to conduit box mounting screw.
- D. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish mechanical-type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.
- E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

- A. Install full length with conductor connection at upper end.
- B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

- A. Install inside buildings, asphalt, and paved areas.
- B. Install riser ring and cover flush with surface.
- C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

- A. General:
 - 1. Above grade Connections: Use either exothermic weld or mechanical-type connectors.
 - 2. Below grade Connections: Install exothermic weld type connectors.

3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
 4. Notify Engineer prior to backfilling ground connections.
- B. Exothermic Weld Type:
1. Wire brush or file contact point to bare metal surface.
 2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
 3. Avoid using badly worn molds.
 4. Mold to be completely filled with metal when making welds.
 5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.
- C. Mechanical Type:
1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
 2. Install in accordance with connector manufacturer's recommendations.
 3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

- A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.
- B. Bond electrical equipment supported by metal platforms to the platforms.
- C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

- A. Install one ground rod inside each.
- B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.
- C. Make connections of grounding conductors fully visible and accessible.
- D. Connect all non current-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

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

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

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

3.11 INSTRUMENT GROUND - SURGE SUPPRESSION

- A. Connect all instrument surge protection with #6 insulated copper ground wire (in conduit where above grade) to closest plant ground system

3.12 BONDING

- A. Bond to Main Conductor System:
 - 1. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
 - 2. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
 - 3. Provide air terminals as required.
- B. Bond steel columns or major framing members to grounding system per National Electrical Code.
- C. Bond each main down conductor to grounding system.

3.13 GROUNDING SYSTEM

- A. Grounding Conductor:
 - 1. Completely encircle building structure.
 - 2. Bury minimum 30 inches below finished grade.
 - 3. Minimum 2 feet distance from foundation walls.
- B. Interconnect ground rods by direct-buried copper cables.
- C. Connections:
 - 1. Install ground cables continuous between connections.
 - 2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
 - 3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
 - 4. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
 - 5. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.
 - 6. Provide electric service arrestor ground wire to building water main.

3.14 FIELD QUALITY CONTROL

- A. As specified in Section 26_08_00 - Electrical Testing.

END OF SECTION

SECTION 26_05_33

RACEWAYS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. 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.
 - c. CS0.5 - Rigid Aluminum Conduit.
 - d. C80.6 - Intermediate Metal Conduit (IMC)-Zinc Coated.
 3. American Society for Testing and Materials (ASTM):
 - a. A123 EI - 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):
 - a. 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.
 - e. VE 1 - Metallic Cable Tray Systems.
 6. National Fire Protection Association (NFPA):
 - a. 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. 797 - Standard for Safety Electrical Metallic Tubing.
 - i. 870 - Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.

- j. 1242 - Standard for Safety Intermediate Metal Conduit.
- k. 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. Electric metallic tubing.
 - c. Rigid aluminum conduit.
 - d. PVC Schedule 40 conduit.
 - e. PVC-coated rigid galvanized steel conduit.
 - f. Flexible metal, liquid-tight conduit.
 - g. Flexible, nonmetallic, liquid-tight conduit.
 - h. Conduit fittings.
 - i. Wireways.
 - 2. Precast Manholes and Handholes:
 - a. Dimensional drawings and descriptive literature.
 - b. Traffic loading calculations.
 - c. Accessory information.
 - 3. Cable Tray Systems:
 - a. Dimensional drawings, calculations, and descriptive information.
 - b. NEMA load/span designation and how it was selected.
 - c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
 - d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
 - e. Layout drawings and list of accessories being provided.
 - 4. Conduit Layout:
 - a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
 - 1) Low and medium voltage feeder and branch circuits.
 - 2) Instrumentation and control systems.
 - 3) Communications systems.
 - 4) Empty conduit for future use.
 - b. Reproducible mylar; scale not greater than 1 inch equals 20 feet.
 - 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. Electric Metallic Tubing (EMT):
 - 1. Meet requirements of ANSI C80.3 and UL 797.
 - 2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.
- C. Rigid Aluminum Conduit:
 - 1. Meet requirements of ANSI C80.5 and UL 6.
 - 2. Material: Type 6063, copper-free aluminum alloy.
- D. 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.
- E. 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.
- F. Flexible Metal, Liquid-Tight Conduit:
 - 1. UL 360 listed for 105 degrees C insulated conductors.
 - 2. Material: Galvanized steel, with an extruded PVC jacket.
- G. 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 and Intermediate Metal 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:
 - c. O-Z/Gedney; Series CH.
 - 1) 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 nonslip 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. Electric Metallic Tubing:
 - 1. Meet requirements of UL 514B.
 - 2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
 - 3. Compression Ring: Stainless steel.
 - 4. Coupling Manufacturers:
 - a. Appleton; Type 95T.
 - b. Crouse-Hinds; Type CPR.
 - 5. Connector Manufacturers:
 - a. Appleton; Type 86T.
 - b. Crouse-Hinds; Type CPR.
- C. Rigid Aluminum Conduit:
 - 1. General:
 - a. Meet requirements of UL 514B.
 - b. Type: Threaded, copper-free. Set screw fittings not permitted.
 - 2. Insulated Bushing:
 - a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
 - b. Manufacturer: O-Z/Gedney; Type AB.
 - 3. Grounding Bushing:
 - a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
 - b. Manufacturer: O-Z/Gedney; Type ABLG.
 - 4. Conduit Hub:
 - a. Material: Cast aluminum, with insulated throat.
 - b. Manufacturers:
 - c. O-Z/Gedney; Type CHA.
 - 1) T & B; Series 370AL.
 - 5. Conduit Bodies:
 - a. Manufacturers (For Normal Conditions):
 - 1) Appleton; Form 85 threaded Unilets.
 - 2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
 - 3) Killark; Series O Electrolets.
 - b. Manufacturers (For Hazardous Locations):
 - 1) Appleton.
 - 2) Crouse-Hinds.
 - 3) Killark.
 - 6. Couplings: As supplied by conduit manufacturer.
 - 7. Conduit Sealing Fitting Manufacturers:
 - a. Appleton; Type EYF-AL or EYM-AL.
 - b. Crouse-Hinds; Type EYS-SA or EZS-SA.
 - c. Killark; Type EY or EYS.
 - 8. Drain Seal Manufacturers:
 - a. Appleton; Type EYDM-A.
 - b. Crouse-Hinds; Type EYD-SA or EZD-SA.
 - 9. Drain/Breather Fitting Manufacturers:
 - a. Appleton; Type ECDB.
 - b. Crouse-Hinds; ECD.

10. Expansion Fitting Manufacturers:
 - a. Deflection/Expansion Movement: Steel City; Type DF-A.
 - b. Expansion Movement Only: Steel City; Type AF-A.
11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.
 - a. Bushing: Neoprene at connector entry.
 - b. Manufacturer: Appleton CG-S.
- D. PVC Conduit and Tubing:
 1. Meet requirements of NEMA TC-3.
 2. Type: PVC, slip-on.
- E. 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.
- F. 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.
 - a. Manufacturer: T & B; Series 5300.
- G. 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.
- H. 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.
- I. Hazardous Locations: Approved for use in the atmosphere involved.
 1. Manufacturer: Crouse-Hinds; Type ECGJH.
- J. 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 raintight if outdoor, and indoor if indoor.
- D. Finish: Gray, baked enamel.
- E. Manufacturers:
 1. Square D.
 2. B-Line Systems, Inc.

2.04 CABLE TRAYS

- A. Meet requirements of NEMA VE 1.
- B. Type: Ladder of welded construction.
- C. Material: Copper-free aluminum alloy 6063-T6 finish.
- D. Cover: Louvered, minimum 0.40-inch thick aluminum.
- E. Barrier Strip: Vertical, solid type, with horizontal fittings and strip clamps.
- F. Fittings of same cross-sectional tray area, and hardware of same material as cable tray.
- G. Tray Grounding: Conform to NFPA 70 and NEMA VE 1.
- H. Provide next higher NEMA VE 1 class designation than required for support of designed span length.
- I. Design Loads: Use working load adequate for actual cable installed plus 50 percent additional weight allowance for future cables plus 200-pound concentrated static load applied between side rails at midspan, with safety factor of 2 in accordance with NEMA VE 1, Table 3-1.
- J. Expansion Joints: NEMA VE 1 for 50 degrees F maximum temperature variation.
- K. Furnish Cable Tray with no sharp edges, burrs, or weld projections.

- L. Manufacturers:
 - 1. B-Line Systems, Inc.
 - 2. Square-D.
 - 3. P. W. Industries.

2.05 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 hole 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.
 - 3. 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.
- I. 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.
- 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.

2.06 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 inches.
 - 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 runs change direction.
 - 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, precoated 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 26_05_05 - 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. Aluminum Conduit: Do not install in direct contact with concrete.
- G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
- H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
- I. Group raceways installed in same area.
- J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.
- K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

- L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
- M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
- N. Install watertight fittings in outdoor, underground, or wet locations.
- O. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
- P. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
- Q. Do not install raceways in concrete equipment pads, foundations, or beams.
- R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
- S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

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: Rigid galvanized steel.
- C. Interior, Exposed:
 - 1. Rigid galvanized steel.
 - 2. Electric metallic tubing for ceiling portion of lighting circuits in a conditioned environment.
- D. Interior, Concealed (Not Embedded in Concrete):
 - 1. Rigid galvanized steel.
 - 2. PVC Schedule 40 for frame walls.
 - 3. Electric metallic tubing for block walls.
- E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.

- F. Direct Earth Burial: PVC-coated rigid galvanized steel.
- G. Concrete-Encased Raceways: PVC Schedule 40.
- H. Under Slabs-On-Grade: PVC Schedule 40.
- I. Corrosive Areas, Exterior: PVC-coated rigid galvanized steel.
- J. Corrosive Areas, Interior: PVC Schedule 80.
- K. Conduits between AFDs and motors PVC coated rigid galvanized steel (inside and outside).
- L. Interior, Ozone Equipment Area: PVC coated rigid galvanized steel.
- M. Lightning Protection: PVC Schedule 40.

3.04 CONNECTIONS

- A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, 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, nonliquid-tight conduit.
- C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.
- D. 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 nonshrink 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 conduit attached to exterior surface of equipment prior to penetrating equipment.
 - c. Seal penetration with silicone type sealant fire stopping rated.
 - 4. Corrosive-Sensitive Areas:
 - a. Seal all conduit passing through chlorine and ammonia room walls.
 - b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
 - c. Seal penetration with silicone type sealant fire stopping rated.
 - 5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
 - 6. Nonwaterproofed 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 Handholes:
 - a. Metallic Raceways: Provide insulated grounding bushings.
 - b. Nonmetallic Raceways: Provide bell ends flush with wall.
 - c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

- A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, 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, strap hangers, or ceiling trapeze as follows:
 - 1. Wood: Wood screws.
 - 2. Hollow Masonry Units: Toggle bolts.
 - 3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
 - 4. Steelwork: Machine screws.
- 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 unbelled 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 CABLE TRAYS

- A. Install in accordance with Application Information Section of NEMA VE 1.
- B. Provide accessories as necessary for a complete system.
- C. Install such that joints are not made at support brackets.
- D. Install horizontal section support brackets between support point and quarter point of tray span.
- E. Provide ceiling trapeze for all horizontal cable tray.
- F. Install support within 2 feet on each side of expansion joints and within 2 feet of fitting extremity.
- G. Provide expansion joints in accordance with NEMA VE 1 for 50 degrees F maximum temperature variation.
- H. Install horizontal tray level, plumb, straight, and true to line or grade within a tolerance of 1/8 inch in 10 feet and within a cumulative maximum of 1/2 inch.
- I. Install vertical tray plumb within a tolerance of 1/8 inch in 10 feet.
- J. Install without exposed raw edges.

- K. Maintain 9-inch vertical separation between multi-tiered trays having a common support, and at all crossover locations.
- L. Provide bonding jumper at each expansion joint and adjustable connection.
- M. Ground Conductor: Provide properly sized clamps for each section, elbow, tee, cross, and reducer.

3.13 TERMINATION AT ENCLOSURES

- A. Cast Metal Enclosure: Provide manufacturer's premolded 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. Electric Metallic Tubing: Provide gland compression, insulated connectors.
 - 3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
 - 4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
 - 5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
 - 6. 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.

3.14 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:
 - 1. Concrete Color: Gray, dust top of concrete duct bank with powdered red concrete dye before concrete sets and trowel dry onto top of duct bank.
- L. Backfill:
 - 1. Do not backfill until inspected by Engineer.

3.15 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 Section 26_05_26 - Grounding.
- E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.16 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.

3.17 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.

3.18 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 26_08_00

ELECTRICAL TESTING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI):
 - a. 450 - Recommended Practice for Maintenance, Testing, and Replacement of Large lead Storage Batteries for Generator Stations and Substations.
 - b. C2 - National Electrical Safety Code.
 - c. C37.20.1 - Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
 - d. C37.20.2 - Metal-Clad and Station-Type Cubicle Switchgear.
 - e. C37.20.3 - Metal-Enclosed Interrupter Switchgear.
 - f. C62.33 - Standard Test Specifications for Varistor Surge- Protective Devices.
 2. American Society for Testing and Materials (ASTM):
 - a. D665 - Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
 - b. DS77 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
 - c. D923 - Standard Test Method for Sampling Electrical Insulating Liquids.
 - d. D924 - Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
 - e. D971 - Standard Test Method for Interfacial Tension of 0.1 Against Water by the Ring Method.
 - f. D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
 - g. D1298 - Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
 - h. D1500 - Standard Test Method for ASTM Color of Petroleum Products.
 - i. D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
 - j. D1533 - Standard Test Methods for Water in Insulating Liquids.
 - k. D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
 - l. D2285 - Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop- Weight Method.
 3. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 43 - Recommended Practice for Testing Insulating Resistance of Rotating Machinery.

- b. 48 - Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.
- c. 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
- d. 95 - Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
- e. 118 - Standard Test Code for Resistance Measurement.
- f. 400 - Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
- 4. National Electrical Manufacturers Association (NEMA):
 - a. AB 4 - Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
 - b. PB 2 -Deadfront Distribution Switchboards.
 - c. WC 7 - Cross-Linked-Thermosetting-Polyethylene-Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - d. WC 8 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- 5. International Electrical Testing Association (NETA): ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- 6. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code (NEC).
 - b. 70E - Standard for Electrical Safety Requirements for Employee Workplaces.

1.02 SUBMITTALS

- A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:
 - 1. Schedule for performing inspection and tests.
 - 2. List of references to be used for each test.
 - 3. Sample copy of equipment and materials inspection form(s).
 - 4. Sample copy of individual device test form.
 - 5. Sample copy of individual system test form.
- B. Quality Control Submittals: Submit within 30 days after completion of test:
 - 1. Test or inspection reports and certificates for each electrical item tested.
- C. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data:
 - a. In accordance with Section 01_78_24 - Operation and Maintenance Data.
 - b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in operation and maintenance manual.

1.03 QUALITY ASSURANCE

- A. Testing Firm Qualifications:
 - 1. Corporately and financially independent organization functioning as an unbiased testing authority.
 - 2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.

3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
 4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.
 5. Technicians certified by NICET or NETA.
 6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
 7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
 8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories or a full Member Company of International Electrical Testing Association.
- B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
- C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Tests specified in this section are to be performed in accordance with the requirements of Section 01_75_17 -Commissioning.
- B. Tests and inspection shall establish that:
1. Electrical equipment is operational within industry and manufacturer's tolerances.
 2. Installation operates properly.

3. Equipment is suitable for energization.
 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.
- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
 - D. Set, test, and calibrate protective relays, circuit breakers, fuses, and other applicable devices in accordance with values established by the short circuit and coordination study.
 - E. Adjust mechanisms and moving parts for free mechanical movement.
 - F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
 - G. Verify nameplate data for conformance to Contract Documents.
 - H. Realign equipment not properly aligned and correct unlevelness.
 - I. Properly anchor electrical equipment found to be inadequately anchored.
 - J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
 - K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
 - L. Provide proper lubrication of applicable moving parts.
 - M. Inform Engineer of working clearances not in accordance with NFPA 70.
 - N. Investigate and repair or replace:
 1. Electrical items that fail tests.
 2. Active components not operating in accordance with manufacturer's instructions.
 3. Damaged electrical equipment.
 - O. Electrical Enclosures:
 1. Remove foreign material and moisture from enclosure interior.
 2. Vacuum and wipe clean enclosure interior.
 3. Remove corrosion found on metal surfaces.
 4. Repair or replace, as determined by Engineer, door and panel sections having dented surfaces.
 5. Repair or replace, as determined by Engineer, poor fitting doors and panel sections.
 6. Repair or replace improperly operating latching, locking, or interlocking devices.
 7. Replace missing or damaged hardware.

- 8. Finish:
 - a. Provide matching paint and touch up scratches and mars.
 - b. If required due to extensive damage, as determined by Engineer, refinish the entire assembly.
- P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.
- Q. Replace transformer insulating oil not in compliance with ASTM D923.

3.02 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

- A. Visual and Mechanical Inspection:
 - 1. Insulator damage and contaminated surfaces.
 - 2. Proper barrier and shutter installation and operation.
 - 3. Proper operation of indicating devices.
 - 4. Improper blockage of air cooling passages.
 - 5. Proper operation of drawout elements.
 - 6. Integrity and contamination of bus insulation system.
 - 7. Check Door and Device Interlocking System By:
 - a. Closure attempt of device when door is in OFF or OPEN position.
 - b. Opening attempt of door when device is in ON or CLOSED position.
 - 8. Check Key Interlocking Systems for:
 - a. Key captivity when device is in ON or CLOSED position.
 - b. Key removal when device is in ON or CLOSED position.
 - c. Closure attempt of device when key has been removed.
 - d. Correct number of keys in relationship to number of lock cylinders.
 - e. Existence of other keys capable of operating lock cylinders.
 - 1) Destroy duplicate sets of keys.
 - 9. Check Nameplates for Proper Identification of:
 - a. Equipment title and tag number with latest one-line diagram.
 - b. Pushbutton.
 - c. Control switch.
 - d. Pilot light.
 - e. Control relay.
 - f. Circuit breaker.
 - g. Indicating meter.
 - 10. Verify that fuse and circuit breaker ratings, sizes, and types conform to those specified,
 - 11. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench thermographic survey applied to bolted joints.
 - a. Ohmic value to be zero.
 - b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
 - c. Thermographic survey temperature gradient of 2 degrees C, or less.
 - 12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:
 - a. Closure attempt for locked open devices.
 - b. Opening attempt for locked closed devices.

- c. Key exchange to operate devices in OFF-NORMAL positions.
- 13. Verify performance of each control device and feature.
- 14. Control Wiring:
 - a. Compare wiring to local and remote control and protective devices with elementary diagrams.
 - b. Proper conductor lacing and bundling.
 - c. Proper conductor identification.
 - d. Proper conductor logs and connections.
- 15. Exercise active components.
- 16. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

B. Electrical Tests:

- 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.1.1.
 - b. Each phase of each bus section.
 - c. Phase-to-phase and phase-to-ground for 1 minute.
 - d. With switches and breakers open.
 - e. With switches and breakers closed.
 - f. Control wiring except that connected to solid state components.
 - g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
- 2. Overpotential Tests:
 - a. Applied ac or dc voltage and test procedure in accordance with ANSI C37.20.3 and NEMA PB 2.
 - b. Each phase of each bus section.
 - c. Phase-to-phase and phase-to-ground for 1 minute.
 - d. Test results evaluated on a pass/fail basis.
- 3. Current Injection Tests:
 - a. For entire current circuit in each section.
 - b. Secondary injection for current flow of 1 ampere.
 - c. Test current at each device.
- 4. Control Wiring:
 - a. Apply secondary voltage to control power and potential circuits.
 - b. Check voltage levels at each point on terminal boards and each device terminal.
- 5. Operational Test:
 - a. Initiate control devices.
 - b. Check proper operation of control system in each section.

3.03 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

- 1. Physical and insulator damage.
- 2. Proper winding connections.
- 3. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
- 4. Defective wiring.
- 5. Proper operation of fans, indicators, and auxiliary devices.

6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Applied megohmmeter DC voltage in accordance with NETA ATS, Table 7.2.3 for each:
 - 1) Winding-to-winding.
 - 2) Winding-to-ground.
 - b. 10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
 - c. Results temperature corrected in accordance with NETA ATS, Table 7.2.4.
 - d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
 - e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.04 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 6 and Larger for:
 - a. Physical damage.
 - b. Proper connections in accordance with single-line diagram.
 - c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
 - d. Color coding conformance with 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.

3.05 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

- A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.
- B. Visual and Mechanical Inspection:
 - 1. Proper mounting.
 - 2. Proper conductor size.
 - 3. Feeder designation according to nameplate and one-line diagram.
 - 4. Cracked casings.
 - 5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
 - 6. Operate breaker to verify smooth operation.
 - 7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
 - 8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.
- C. Electrical Tests:
 - 1. Insulation Resistance Tests:
 - a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
 - b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
 - c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
 - d. Test values to comply with NETA ATS, Table 10.2.
 - 2. Contact Resistance Tests:
 - a. Contact resistance in microhms across each pole.
 - b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
 - 3. Primary Current Injection Test to Verify:
 - a. Long-time minimum pickup and delay.
 - b. Short-time pickup and delay.
 - c. Ground fault pickup and delay.
 - d. Instantaneous pickup by run-up or pulse method.
 - e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.
 - g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.06 PROTECTIVE RELAYS

- A. Visual and Mechanical Inspection:
 - 1. Visually Check Each Relay for:
 - a. Tight cover gasket and proper seal.
 - b. Unbroken cover glass.
 - c. Condition of spiral spring and contacts.
 - d. Disc clearance.
 - e. Condition of case shorting contacts if present.
 - 2. Mechanically Check Each Relay for:
 - a. Freedom of movement.
 - b. Proper travel and alignment.
 - 3. Verify That Each Relay:
 - a. Complies with Contract Documents and application.
 - b. Is set in accordance with recommended settings.
- B. Electrical Tests:
 - 1. Insulation resistance test on each circuit to frame except for solid state devices.
 - 2. Tests on Nominal Recommended Setting for:
 - a. Pickup parameters on each operating element.
 - b. Timing at three points on time-current curve.
 - c. Pickup target and seal-in units.
 - d. Special tests as required to check operation of restraint, directional, and other elements in accordance with manufacturer's instruction manual.
 - 3. Phase angle and magnitude contribution tests on differential and directional relays after energization to vectorially verify proper polarity and connections.
 - 4. Current Injection Tests:
 - a. For entire current circuit in each section.
 - b. Secondary injection for current flow of 1 ampere.
 - c. Test current at each device.

3.07 INSTRUMENT TRANSFORMERS

- A. Visual and Mechanical Inspection:
 - 1. Visually Check Current, Potential, and Control Transformers for:
 - a. Cracked insulation.
 - b. Broken leads or defective wiring.
 - c. Proper connections.
 - d. Adequate clearances between primary and secondary circuit wiring.
 - 2. Verify Mechanically That:
 - a. Grounding and shorting connections have good contact.
 - b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
 - 3. Verify proper primary and secondary fuse sizes for potential transformers.

- B. Electrical Tests:
 - 1. Current Transformer Tests:
 - a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts DC for 30 seconds.
 - b. Polarity test.
 - 2. Potential Transformer Tests:
 - a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:
 - 1) Winding-to-winding.
 - 2) Winding-to-ground.
 - b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
 - 3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.08 METERING

- A. Visual and Mechanical Inspection:
 - 1. Verify meter connections in accordance with appropriate diagrams.
 - 2. Verify meter multipliers.
 - 3. Verify that meter types and scales conform to Contract Documents.
 - 4. Check calibration of meters at cardinal points.
 - 5. Check calibration of electrical transducers.

3.09 GROUNDING SYSTEMS

- A. Visual and Mechanical Inspection:
 - 1. Equipment and circuit grounds in motor control centers, panelboards, switchboards, and switchgear assemblies for proper connection and tightness.
 - 2. Ground bus connections in motor control centers, panelboards, switchboards, and switchgear assemblies for proper termination and tightness.
 - 3. Effective transformer core and equipment grounding.
 - 4. Accessible connections to grounding electrodes for proper fit and tightness.
 - 5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.
- B. Electrical Tests:
 - 1. Fall-of-Potential Test:
 - a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
 - b. Main ground electrode system resistance to ground to be no greater than 5 ohms.
 - 2. Two-Point Direct Method Test:
 - a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
 - b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.10 GROUND FAULT SYSTEMS

- A. Inspection and Testing Limited to:
 - 1. Zero sequence grounding systems.
 - 2. Residual ground fault systems.
- B. Visual and Manual Inspection:
 - 1. Neutral Main Bonding Connection to Ensure:
 - a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
 - b. Ground strap sensing system is grounded through sensing device.
 - c. Neutral ground conductor is solidly grounded.
 - 2. Verify that control power has adequate capacity for system.
 - 3. Manually Operate Monitor Panels for:
 - a. Trip test.
 - b. No trip test.
 - c. Nonautomatic rest.
 - 4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
 - 5. Relay check for pickup and time under simulated ground fault conditions.
 - 6. Verify nameplate identification by device operation.
- C. Electrical Tests:
 - 1. Test system neutral insulation resistance with neutral ground link removed. System neutral insulation resistance minimum 1 megohm.
 - 2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.
 - 3. Test relay timing by injecting 300 percent of pickup current, or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
- D. Test system operation at 55 percent rated control voltage, if applicable.
- E. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.11 AC INDUCTION MOTORS

- A. General: Inspection and testing limited to motors rated 5 horsepower and larger.
- B. Visual and Mechanical Inspection:
 - 1. Proper electrical and grounding connections.
 - 2. Shaft alignment.
 - 3. Blockage of ventilating air passageways.
 - 4. Operate Motor and Check for:
 - a. Excessive mechanical and electrical noise.
 - b. Overheating.
 - c. Correct rotation.

- d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionality and proper operation.
 - e. Excessive vibration.
 - 5. Check operation of space heaters.
- C. Electrical Tests:
 - 1. Insulation Resistance Tests:
 - a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
 - 1) Motors above 200 horsepower for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
 - 2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
 - b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
 - 2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
 - 3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
 - 4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
 - 5. Overpotential Tests:
 - a. Applied dc voltage in accordance with IEEE 95.
 - b. Limited to 4,000-volt motors rated 1,000 horsepower and greater.
 - c. Test results evaluated on pass/fail basis.

3.12 LOW VOLTAGE MOTOR CONTROL

- A. Visual and Mechanical Inspection:
 - 1. Proper barrier and shutter installation and operation.
 - 2. Proper operation of indicating and monitoring devices.
 - 3. Proper overload protection for each motor.
 - 4. Improper blockage of air cooling passages.
 - 5. Proper operation of drawout elements.
 - 6. Integrity and contamination of bus insulation system.
 - 7. Check Door and Device Interlocking System By:
 - a. Closure attempt of device when door is in OFF or OPEN position.
 - b. Opening attempt of door when device is in ON or CLOSED position.
 - 8. Check Key Interlocking Systems for:
 - a. Key captivity when device is in ON or CLOSED position.
 - b. Key removal when device is in OFF or OPEN position.
 - c. Closure attempt of device when key has been removed.
 - d. Correct number of keys in relationship to number of lock cylinders.
 - e. Existence of other keys capable of operating lock cylinders; destroy duplicate sets of keys.
 - 9. Check Nameplates for Proper Identification Of:
 - a. Equipment title and tag number with latest one-line diagram.
 - b. Pushbuttons.
 - c. Control switches.

- d. Pilot lights.
- e. Control relays.
- f. Circuit breakers.
- g. Indicating meters.
- 10. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
- 11. Verify that current and potential transformer ratios conform to Contract Documents.
- 12. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Thermographic Survey:
 - a. Ohmic value to be zero.
 - b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
 - c. Thermographic survey temperature gradient of 2 degrees Celsius, or less.
- 13. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:
 - a. Closure attempt for locked open devices.
 - b. Opening attempt for locked closed devices.
 - c. Key exchange to operate devices in OFF-NORMAL positions.
- 14. Verify performance of each control device and feature furnished as part of the motor control center.
- 15. Control Wiring.
- 16. Compare wiring to local and remote control, and protective devices with elementary diagrams.
- 17. Check for proper conductor lacing and bundling.
- 18. Check for proper conductor identification.
 - a. Check for proper conductor lugs and connections.
- 19. Exercise active components.
- 20. Inspect Contactors for:
 - a. Correct mechanical operations.
 - b. Correct contact gap, wipe, alignment, and pressure.
 - c. Correct torque of all connections.
- 21. Compare overload heater rating with full-load current for proper size.
- 22. Compare motor protector and circuit breaker with motor characteristics and power factor correction capacitors for proper size.
- 23. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

- 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
 - b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
 - c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
 - d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
 - e. Test values to comply with NETA ATS, Table 10.2.

2. Overpotential Tests:
 - a. Maximum applied ac or dc voltage in accordance with NETA ATS, Table 7.1.2.
 - b. Phase-to-phase and phase-to-ground for 1 minute for each phase of each bus section.
 - c. Test results evaluated on pass/fail basis.
3. Current Injection Through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
 - a. Trip time in accordance with manufacturer's published data.
 - b. Investigate values in excess of 120 seconds.
4. Control Wiring Tests:
 - a. Apply secondary voltage to control power and potential circuits.
 - b. Check voltage levels at each point on terminal boards and each device terminal.
 - c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.
 - 1) Insulation resistance to be 1 megohm minimum.
5. Operational test by initiating control devices to affect proper operation.

3.13 AUTOMATIC TRANSFER SWITCHES

- A. Visual and Mechanical Inspection:
 1. Check doors and panels for proper interlocking.
 2. Check connections for high resistance by low resistance ohmmeter.
 3. Check positive mechanical and electrical interlock between normal and alternate sources.
 4. Check for Proper Operation:
 - a. Manual transfer function switch.
 - b. Generator under load and non-load conditions.
 - c. Auto-exerciser of generator under load and no-load conditions.
 5. Verify settings and operation of control devices.
- B. Electrical Tests:
 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2 for each phase with switch CLOSED in both source positions.
 - b. Phase-to-phase and phase-to-ground for 1 minute.
 - c. Test values in accordance with manufacturer's published data.
 2. Contact Resistance Test:
 - a. Contact resistance in microhms across each switch blade for both source positions.
 - b. Investigate values exceeding 500 micro-ohms.
 - c. Investigate values deviating from adjacent pole by more than 50 percent.
 3. Set and Calibrate in Accordance with Specifications:
 - a. Voltage and frequency sensing relays.
 - b. Time delay relays.
 - c. Engine start and shutdown relays.
 4. Perform Automatic Transfer Tests By:
 - a. Simulating loss of normal power.
 - b. Return to normal power.

- c. Simulating loss of alternate power.
- d. Simulating single-phase conditions for normal and alternate sources.
- 5. Monitor and Verify Operation and Timing Of:
 - a. Normal and alternate voltage sensing relays.
 - b. Engine start sequence.
 - c. Timing delay upon transfer and retransfer.
 - d. Engine cool down and shutdown.
 - e. Interlocks and limit switch functions.
 - f. Engine cool down and shutdown feature.

3.14 BATTERY SYSTEM

- A. Visual and Mechanical Inspection:
 - 1. Physical damage and electrolyte leakage.
 - 2. Evidence of corrosion.
 - 3. Intercell bus link integrity.
 - 4. Battery cable insulation damage and contaminated surfaces.
 - 5. Operating conditions of ventilating equipment.
 - 6. Visual check of electrolyte level.
- B. Electrical Tests:
 - 1. Measure:
 - a. Bank charging voltage.
 - b. Individual cell voltage.
 - c. Electrolyte specific gravity in each cell.
 - d. Measured test values to be in accordance with manufacturer's published data.
 - 2. Verify During Recharge Mode:
 - a. Charging rates from charger.
 - b. Individual cell acceptance of charge.
 - 3. Load tests for integrity and capacity; test values in accordance with ANSI 450.

3.15 LOW VOLTAGE SURGE ARRESTORS

- A. Visual and Mechanical Inspection:
 - 1. Adequate clearances between arrestors and enclosures.
 - 2. Ground connections to ground bus or electrode.
- B. Electrical Tests:
 - 1. Varistor Type Arrestors:
 - a. Clamping voltage test.
 - b. Rated RMS voltage test.
 - c. Rated dc voltage test.
 - d. Variator arrester test values in accordance with ANSI C62.33, Sections 4.4 and 4.7.

3.16 STANDBY AND EMERGENCY GENERATOR SYSTEMS

- A. Visual and Mechanical Inspection:
 - 1. Proper grounding.

2. Blockage of ventilating passageways.
3. Proper operation of jack water heaters.
4. Integrity of engine cooling and fuel supply systems.
5. Excessive mechanical and electrical noise.
6. Overheating of engine or generator.
7. Proper installation of vibration isolators.
8. Proper cooling liquid type and level.
9. Operate Engine-Generator and Check for:
 - a. Excessive mechanical and electrical noise.
 - b. Overheating.
 - c. Correct rotation.
 - d. Check resistance temperature detectors or generator inherent thermal protectors for functionality and proper operation.
 - e. Excessive vibration.
10. Verify that voltage regulator and governor operation will cause unit speed and output voltage to stabilize at proper values within reasonable length of time.
11. Proper operation of meters and instruments.
12. Compare generator nameplate rating and connection with one-line diagram.
13. Verify engine-generator operation with adjustable frequency drives energized and operating under normal load conditions.

B. Electrical and Mechanical Tests:

1. Cold start test by interrupting normal power source with test load consisting of connected building load to verify:
 - a. Transfer switch operation.
 - b. Automatic starting operation.
 - c. Operating ability of engine-generator.
 - d. Overcurrent devices capability to withstand inrush currents.
2. Phase rotation tests.
3. Test Engine Protective Shutdown Features for:
 - a. Low oil pressure.
 - b. Overtemperature.
 - c. Overspeed.
4. Vibration base-line test on generator sets rated above 250 kW; levels in accordance with manufacturer's recommendations.
5. Load bank test with reactors and resistors adjusted to 80 percent power factor for each load step. Record voltage, frequency, load current, oil pressure, and engine coolant temperature at 15-minute intervals:
 - a. 25 percent applied load for 30 minutes.
 - b. 50 percent applied load for 30 minutes.
 - c. 75 percent applied load for 30 minutes.
 - d. 100 percent applied load for 3 hours.
 - e. Load test results to demonstrate ability of unit to deliver rated load for test period.
6. One-Step Rated kW Load Pickup Test:
 - a. Perform test immediately after performing load bank test.
 - b. Apply rated load, minus largest rated horsepower motor, to generator.
 - c. Start largest rated horsepower motor and record voltage drop for 20 cycles minimum with high-speed chart recorder or digital storage oscilloscope.

- d. Compare voltage drop with maximum allowable voltage dip for specified starting situation.

3.17 THERMOGRAPHIC SURVEY

- A. Provide a thermographic survey of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 2 and larger at each:
 - 1. Medium voltage switchgear and transformer.
 - 2. Switchboard.
 - 3. Low voltage motor control center.
 - 4. Panelboard.
- B. Provide a thermographic survey of feeder conductors No. 2 and larger terminating at:
 - 1. Motors rated 30 horsepower and larger.
 - 2. Medium and low voltage disconnect switches.
 - 3. Transfer switches.
 - 4. Engine-generators.
- C. Remove necessary enclosure metal panels and covers prior to performing survey.
- D. Perform with equipment energized during periods of maximum possible loading.
- E. Do not perform survey on equipment operating at less than 20 percent of rated connected operating load.
- F. Utilize Thermographic Equipment Capable Of:
 - 1. Detecting emitted radiation.
 - 2. Converting detected radiation to visual signal.
 - 3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees Celsius.
- G. Temperature Gradients Of:
 - 1. 3 degrees Celsius to 7 degrees Celsius indicates possible deficiency that warrants investigation.
 - 2. 7 degrees Celsius to 15 degrees Celsius indicates deficiency that is to be corrected as time permits.
 - 3. 16 degrees Celsius and above indicates deficiency that is to be corrected immediately.
- H. Provide Written Report Of:
 - 1. Areas surveyed and the resultant temperature gradients.
 - 2. Locations of areas having temperature gradients of 3 degrees Celsius or greater.
 - 3. Cause of heat rise and actions taken to correct the cause of heat rise.
 - 4. Detected phase unbalance.

END OF SECTION

SECTION 26_20_00
ELECTRICAL MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Anti-Friction Bearing Manufacturers' Association (AFBMA):
 - a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11 - Load Rating and Fatigue Life for Roller Bearings.
 2. American National Standards Institute (ANSI):
 - a. C50.41 - Polyphase Induction Motors for Power Generating Stations.
 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 85 - Test Procedure for Airborne Sound Measurements on Rotating Machines.
 - b. 112 - Standard Test Procedures for Polyphase Induction Motors and Generators.
 - c. 114 - Standard Test Procedures for Single-Phase Induction Motors.
 - d. 620 - Guide for Construction and Interpretation of Thermal Limit Curves for Squirrel-Cage Motors Over 500 Horsepower.
 - e. 841 - Recommended Practice for Chemical Industry Severe-Duty Squirrel-Cage Induction Motors, 600V and Below.
 4. National Electrical Manufacturers Association (NEMA):
 - a. MG 1 - Motors and Generators.
 - b. MG 13 - Frame Assignments for Alternating Current Integral Horsepower Induction Motors.
 - c. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).
 5. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code. (NEC)
 6. Underwriters Laboratories (UL):
 - a. 547 - Thermal Protectors for Electric Motors.
 - b. 674 - Electric Motors and Generators Used in Hazardous (Classified) Locations.

1.03 DEFINITIONS

- A. CISC-TEFC: Chemical industry, severe-duty enclosure.
- B. DIP: Dust-ignition-proof enclosure.
- C. EXP: Explosion-proof enclosure.
- D. ODP: Open drip-proof enclosure.
- E. TEFC: Totally enclosed, fan cooled enclosure.
- F. TENV: Totally enclosed, nonventilated enclosure.
- G. WPI: Open weather protected enclosure, Type I.
- H. WPIL: Open weather protected enclosure, Type II.
- I. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Descriptive information.
 - 2. Nameplate data in accordance with NEMA MG 1.
 - 3. Additional Rating Information:
 - a. Service factor.
 - b. Locked rotor current.
 - c. No load current.
 - d. Safe stall time for motors 200 horsepower and larger.
 - e. Multispeed load classification (e.g., variable torque).
 - f. Adjustable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.
 - 4. Enclosure type and mounting (e.g. horizontal, vertical).
 - 5. Dimensions and total weight.
 - 6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
 - 7. Bearing type.
 - 8. Bearing lubrication.
 - 9. Bearing life.
 - 10. Space heater voltage and watts.
 - 11. Description and rating of motor thermal protection.
 - 12. Motor sound power level in accordance with NEMA MG 1.
 - 13. Maximum brake horsepower required by the equipment driven by the motor.
 - 14. Description and rating of submersible motor moisture sensing system.

- B. Quality Control Submittals:
 - 1. Factory test reports, certified.
 - 2. Manufacturer's Certificate of Proper Installation, 100 horsepower and larger.
 - 3. Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. General Electric.
- B. Reliance.
- C. MagneTek.
- D. Siemens.
- E. Balder.
- F. U.S. Motors.
- G. Westinghouse.
- H. Toshiba.

2.02 GENERAL

- A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
- B. In order to obtain single source responsibility, utilize a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.
- C. Meet requirements of NEMA MG 1.
- D. Frame assignments in accordance with NEMA MG 13.
- E. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.
- F. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
- G. Lifting lugs on all motors weighing 100 pounds or more.

- H. Operating Conditions:
1. Maximum ambient temperature not greater than 50 degrees C.
 2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
 3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

- A. As designated in motor-driven equipment specifications.
- B. Constant Speed Applications: Brake horsepower of the driven equipment at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.
- C. Adjustable Frequency, Adjustable Speed Applications: Driven equipment brake horsepower at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

2.04 SERVICE FACTOR

- A. 1.15 minimum at rated ambient temperature, unless otherwise indicated.

2.05 VOLTAGE AND FREQUENCY RATING

- A. System Frequency: 60-Hz.
- B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

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

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

2.06 EFFICIENCY AND POWER FACTOR

- A. For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
1. Efficiency:
 - a. Tested in accordance with NEMA MG 1, Paragraph 12.54.1.

- b. Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.
- 2. Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.07 LOCKED ROTOR RATINGS

- A. Locked rotor kVA Code F or lower if motor horsepower not covered by NEMA MG 1 tables.
- B. Safe stall time 15 seconds or greater.

2.08 INSULATION SYSTEMS

- A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.
- B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.
- C. Three-Phase and Integral Horsepower Motors, Unless Otherwise Indicated in Motor-Driven Equipment Specifications: Class F with Class B rise at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise.

2.09 ENCLOSURES

- A. All enclosures to conform to NEMA MG 1.
- B. Unless otherwise noted, all motors shall be TEFC and shall furnish with a drain hole with porous drain/weather plug.
- C. Explosion-Proof (EXP):
 - 1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group C and D hazardous locations.
 - 2. Drain holes with drain and breather fittings.
 - 3. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
 - 4. Thermostat leads to terminate in a terminal box separate from main terminal box.
- D. Dust-Ignition-Proof (DIP):
 - 1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class II, Division 1, Group E, F, G.
 - 2. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
 - 3. Thermostat leads to terminate in a terminal box separate from main terminal box.

- E. Submersible: In accordance with Article 2.16 SPECIAL MOTORS.
- F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article 2.16 SPECIAL MOTORS.

2.10 TERMINAL (CONDUIT) BOXES

- A. Oversize main terminal boxes for all motors.
- B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.
- C. Except ODP, furnish gaskets between box halves and between box and motor frame.
- D. Minimum usable volume in percentage of that specified in NEMA MG 1-11.06 and 20.62 and NFPA 70, Article 430:

Voltage	Horsepower	Percentage
Below 600	15 thru 125	500
Below 600	150 thru 300	275
Below 600	350 thru 600	225
Above 600	All Sizes	200

- E. Terminal for connection of equipment grounding wire in each terminal box.

2.11 BEARINGS AND LUBRICATION

- A. Horizontal Motors:
 - 1. 3/4 horsepower and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
 - 2. 1 Through 400 horsepower: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
 - 3. Above 400 horsepower: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.
 - 4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in AFBMA 9 and 11.
- B. Vertical Motors:
 - 1. Thrust Bearings:
 - a. Antifriction bearing.
 - b. Manufacturer's standard lubrication 100 horsepower and larger.
 - c. Oil lubricated 125 horsepower and larger.
 - d. Minimum 50,000 hours L-10 bearing life.
 - 2. Guide Bearings:
 - a. Manufacturer's standard bearing type.
 - b. Manufacturer's standard lubrication 200 horsepower and larger.

- c. Oil lubricated 250 horsepower and larger.
 - d. Minimum 100,000 hours L-10 bearing life.
- C. Regreasable Antifriction Bearings:
 - 1. Readily accessible, grease injection fittings.
 - 2. Readily accessible, removable grease relief plugs.
- D. Oil Lubrication Systems:
 - 1. Oil reservoirs with sight level gauge.
 - 2. Oil fill and drain openings with opening plugs.
 - 3. Provisions for necessary oil circulation and cooling.

2.12 NOISE

- A. Measured in accordance with IEEE 85 and NEMA MG 1.
- B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

- A. In accordance with NEMA MG 1-12.06.

2.14 EQUIPMENT FINISH

- A. External Finish: Prime and finish coat manufacturer's standard. Field painting in accordance with Section 09_96_01 - High-Performance Coatings.
- B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

- A. Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPIL enclosures meeting requirements for Guarded Machine in NEMA MG 1.
- B. Winding Thermal Protection:
 - 1. Thermostats:
 - a. Motors for constant speed and adjustable speed application 30 through 75 horsepower.
 - b. Bi-metal disk or rod type thermostats embedded in stator windings (normally closed contact).
 - c. Automatic reset contacts rated 120 volts AC, 5 amps minimum, opening on excessive temperature. (Manual reset will be provided at motor controller.)
 - 2. Thermistors:
 - a. Motors for constant speed and adjustable speed application 100 horsepower and larger.
 - b. Thermistor embedded in each stator phase winding before winding dip and bake process.
 - c. In intimate contact with winding conductors.

- d. Epoxy-potted, solid state thermistor control module mounted in NEMA 250, Type 4X box on motor by motor manufacturer.
 - e. Individual thermistor circuits factory-wired to control module.
 - f. Control module rated for 120 volts AC power supply.
 - g. Control module automatically reset contact for external use rated 120 volts AC, 5 amps minimum, opening on abnormally high winding temperature. Manual reset will be provided at motor controller.
3. Motor Space Heaters: All motors 30 horsepower and larger except if otherwise noted, shall be furnished with 120V AC space heaters. The rating of the space heaters shall be determined in accordance with the motor manufacturer's standard for particular frame size and type. Coordinate the power requirements of the space heater with the manufacturer of motor starters or adjustable frequency drive for sizing of the control transformer. Space heater wire leads shall be brought out in the conduit box on the motor and clearly identified.
- C. Nameplates:
- 1. Raised or stamped letters on stainless steel or aluminum.
 - 2. Display all motor data required by NEMA MG 1-10.37 and NEMA MG 1-10.38 in addition to bearing numbers for both bearings.
 - 3. Premium efficiency motor nameplates to also display NEMA nominal efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

2.16 SPECIAL MOTORS

- A. Requirements in this Article take precedence over conflicting features specified elsewhere in this section.
- B. Chemical Industry, Severe-Duty (CISD-TEFC):
- 1. In accordance with IEEE 841.
 - 2. TEFC in accordance with NEMA MG 1.
 - 3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
 - 4. Motor Frame, End Shields, Terminal Box(es), and Fan Cover: Cast iron.
 - 5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
 - 6. Drain and Breather Fittings: Stainless steel.
 - 7. Nameplate: Stainless steel.
 - 8. Gaskets between terminal box halves and terminal box and motor frame.
 - 9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
 - 10. Double shielded bearings.
 - 11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
 - 12. External Finish: Double-coated epoxy enamel.
 - 13. Coated rotor and stator air gap surfaces.
 - 14. Insulation System, Windings, and Connections:
 - a. Class F insulation, Class B rise or better at 1.0 service factor.
 - b. Multiple dips and bakes of nonhygroscopic polyester varnish.
 - 15. Service Factor:
 - a. At 40 Degrees C Ambient: 1.15.
 - b. At 65 Degrees C Ambient: 1.00.

16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.
- C. Severe-Duty Explosion-Proof: Meet requirements for EXP enclosures and CISC-TEFC motors.
- D. Severe-Duty, Dust-Ignition-Proof: Meet requirements for DIP enclosures and CISC-TEFC motors.
- E. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.

F. Submersible Pump Motors:

1. Manufacturers:
 - a. Reliance.
 - b. Flygt.
2. At 100 Percent Load:

Horsepower	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
5 thru 10	80	82
10.1 thru 50	85	82
50 1 thru 100	87	82
Over 100	89	82

3. Insulation System: Manufacturer's standard Class B or Class F.
4. Motor capable of running dry continuously.
5. Enclosure:
 - a. Hermetically sealed, watertight, for continuous submergence up to 65-foot depth.
 - b. Listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group D hazardous atmosphere.
 - c. Seals: Tandem mechanical.
6. Bearing and Lubrication:
 - a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.
 - b. Minimum 15,000 hours L-10 bearing life.
7. Inrush kVA/horsepower no greater than NEMA MG 1 and NFPA 70, Code F.
8. Winding Thermal Protection:
 - a. Thermal sensor and switch assembly, one each phase, embedded in stator windings and wired in series.
 - b. Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.
 - c. Switch contacts rated at 5 amps, 120 volts AC.
9. Motor Seal Failure Moisture Detection:
 - a. Probes or sensors to detect moisture beyond seals.
 - b. Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120-volt AC supply.

- c. Monitoring module with control power transformer, probe test switch and test light, and two independent 120-volt AC contacts, one opening and one closing when the flux of moisture is detected.
- 10. Bearing Overtemperature Protection for Motors Larger than 100 Horsepower:
 - a. Sensor on lower bearing housing monitoring bearing temperature.
 - b. Any monitoring relay necessary to provide 120-volt AC contact opening on bearing overtemperature.
- 11. Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by a single device providing two independent 120-volt AC contacts, one closing and one opening on malfunction.
- 12. Connecting Cables:
 - a. One cable containing power, control, and grounding conductors.
 - b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.
 - c. Length: 30 feet minimum, coordinate proper length.
 - d. UL 1 listed and sized in accordance with NFPA 70.
- G. Inclined Motors:
 - 1. Motors suitable for operation only in horizontal position not acceptable.
 - 2. Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.
 - 3. Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.
- H. Motors for Adjustable Frequency Drives (AFDs): These motors shall be specially designed inverter duty motors and comply with NEMA MG 1.31. Motor insulation shall withstand high voltages caused by fast rise time voltage pulses associated with PWM type inverters. Motor design shall take into account motor heating caused by harmonics in the drive output. Each motor for AFD application shall have a label certifying that the motor is suitable for inverter duty. Coordinate the motor full load current data with the drive manufacturer.

2.17 FACTORY TESTING

- A. Tests:
 - 1. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
 - 2. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.
 - 3. For energy efficient motors, test efficiency at 50, 75, and 100 percent of rated horsepower:
 - a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraphs 12.54 and 12.57.
 - b. For motors 500 horsepower and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
 - 4. Power factor:
 - a. Speed.

- b. Current at rated horsepower.
- c. kW input at rated horsepower.
- d. On motors of 100 horsepower and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

B. Test Report Forms:

- 1. Routine Tests: IEEE 112, Form A-1.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with manufacturer's instructions and recommendations.
- B. Align motor carefully and properly with driven equipment.
- C. Secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

3.02 FIELD QUALITY CONTROL

- A. Refer to Section 26_08_00 - Electrical Testing.

3.03 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative at site for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 75 horsepower.
- B. Manufacturer's Certificate of Proper Installation.

3.04 SUPPLEMENTS

- A. Table supplement, following "END OF SECTION," is a part of this Specification.
 - 1. Table 1, Motor Performance Requirements.

END OF SECTION

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
hp	Nominal Speed rpm	% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
		Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC
1	1,800	80.0	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1,200	78.5	79.3			Mfr.'s Std.	Mfr.'s Std.		
1.5	3,600	79.3	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1,800	79.3	82.0			Mfr.'s Std.	Mfr.'s Std.		
	1,200	82.5	84.0		82.0	Mfr.'s Std.	Mfr.'s Std.		Mfr.'s Std.
2	3,600	82.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1,800	81.5	83.7			Mfr.'s Std.	Mfr.'s Std.		
	1,200	85.5	85.5	83.7	83.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	82.9	82.5	82.9	81.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
3	3,600	82.0	84.0	82.0	82.0	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	84.1	82.9	84.1	82.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
5	3,600	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	86.5	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
hp	Nominal Speed rpm	% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
		Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC
7.5	3,600	86.5	88.1	84.8	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	88.5	88.5	88.4	87.5	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
10	3,600	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	89.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
15	3,600	88.5	89.8	88.4	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	91.0	91.0	90.9	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	90.2	90.2	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
20	3,600	91.0	90.6	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	91.7	91.7	91.7	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	91.0	90.6	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
hp	Nominal Speed rpm	% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
		Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC
25	3,600	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	91.7	91.0	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
30	3,600	91.7	91.4	89.5	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	91.7	91.7	90.9	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
40	3,600	91.7	91.7	90.2	89.3	86.6	86.1	87.0	89.0
	1,800	93.6	93.0	92.8	91.7	78.2	78.2	83.0	84.5
	1,200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.0	90.9	90.2	70.0	70.5	70.0	70.5
50	3,600	92.0	92.0	90.2	89.3	85.1	86.7	89.0	89.0
	1,800	93.6	93.0	92.8	91.7	79.5	79.4	82.5	82.5
	1,200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.7	90.9	90.9	78.5	72.9	78.5	80.0

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
hp	Nominal Speed rpm	% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
		Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC
60	3,600	92.7	93.0	91.7	90.9	85.8	88.3	87.5	89.0
	1,800	93.6	94.1	93.5	92.8	80.5	79.9	80.5	80.5
	1,200	93.0	93.0	92.8	91.7	81.5	81.5	81.5	81.5
	900	92.4	91.7	91.7	90.9	79.5	73.2	79.5	79.5
70	3,600	93.6	93.6	91.7	91.7	87.1	88.5	88.5	88.5
	1,800	94.5	94.5	93.5	93.5	81.0	81.5	81.0	81.5
	1,200	93.6	93.5	93.5	92.8	82.0	82.0	82.0	82.0
	900	92.8	92.4	92.8	91.7	80.5	74.5	80.5	81.0
100	3,600	93.6	93.3	91.7	90.7	87.0	88.2	87.0	88.5
	1,800	95.1	94.5	94.0	93.5	81.0	81.0	81.0	81.0
	1,200	93.6	93.6	92.8	92.8	82.1	81.7	85.5	85.5
	900	93.5	92.4	92.8	91.7	77.0	77.3	77.0	80.0
125	3,600	93.6	93.7	91.7	91.7	86.4	89.1	87.0	90.5
	1,800	94.5	94.7	93.5	92.8	85.4	85.5	87.5	86.0
	1,200	93.6	94.1	93.5	92.8	82.7	82.3	85.5	85.5
	900	93.5	93.0	92.8	92.4	78.5	78.5	78.5	78.5

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
hp	Nominal Speed rpm	% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
		Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC
150	3,600	93.6	93.7	92.4	91.7	86.5	90.0	86.5	90.5
	1,800	95.0	95.2	94.5	94.0	82.5	85.0	84.5	85.0
	1,200	94.5	94.5	93.5	94.0	81.5	81.5	81.5	81.5
	900	93.5	93.0	92.8	92.4	78.0	78.5	78.0	78.5
200	3,600	94.3	94.3	92.4	93.0	87.8	89.4	91.0	91.0
	1800	95.0	95.2	94.0	94.0	85.2	86.5	87.0	87.0
	1,200	94.5	94.5	93.5	93.5	79.0	82.5	79.0	82.5
250	3,600	94.3	94.7	91.7	92.4	85.0	86.5	85.0	96.5
	1,800	85.4	95.4	94.5	94.5	79.0	79.0	79.0	79.0
	1,200	95.0	94.5	94.5	93.5	82.0	82.0	82.0	82.0
300	3,600	93.7	94.3			89.8	89.9		
	1,800	95.4	95.2	94.5	94.0	80.0	80.0	80.0	80.0
	1,200	93.7	93.7			84.5	90.1		
350	3,600	94.3	94.7			89.4	85.9		
	1,800	94.7	94.7			85.9	85.9		

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
hp	Nominal Speed rpm	% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
		Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC	Drip-Proof ODP	TEFC
400	3,600	94.3				88.4			
	1,800	94.37				86.8			
450	3,600	94.7				89.1			
500	3,600	94.7				88.3			

END OF SECTION

SECTION 40_05_00.01

COMMON WORK RESULTS FOR GENERAL PIPING

PART 1 GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME):
 - 1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24.
 - 2. B16.47 - Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard.
- B. American Water Works Association (AWWA):
 - 1. C207 - Standard for Steel Pipe Flanges for Waterworks Services-Size 4 In. Through 144 In.
- 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. A320 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
 - 5. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - 6. B88 - Standard Specification for Seamless Copper Water Tube.
 - 7. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
 - 8. D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings.
 - 9. F37 - Standard Test Methods for Sealability of Gasket Materials.
 - 10. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 11. F594 – Standard Specification for Stainless Steel Nuts.
 - 12. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements of Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

1.03 DEFINITIONS

- A. Buried pipes: Pipes that are buried in the soil with or without a concrete pipe encasement.
- B. Exposed pipe: Pipes that are located above ground, or located inside a structure, supported by a structure, or cast into a concrete structure.
- C. Underground pipes: Buried pipes - see A. above.
- D. Underwater pipes: Pipes below the top of walls containing water.
- E. Wet wall: A wall with water on at least 1 side.
- F. Pipes adjacent to a wet wall: Pipe centerline within 10 inches of the wet wall.

PART 2 PRODUCTS

2.01 GENERAL

- A. Materials as specified in Section 01_60_00 - Product Requirements.
- B. General:
 - 1. Bolts and nuts material shall be stainless steel
 - 2. Washer:
 - a. Provide a washer for each nut and bolt.
 - b. Washer shall be of the same material as the nut.
 - 3. Nuts: Heavy hex-head.

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 Contractor's field personnel.
 - b) Periodically visit the jobsite to verify 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 1 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.
 - 4. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.
- B. Exposed piping:
- 1. Install exposed piping 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 exposed piping after installing equipment and after piping and fitting locations have been determined.
 - 3. Support piping: As indicated on the Drawings.
 - a. Do not transfer pipe loads and strain to equipment.
 - 4. 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.
 - 5. 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.
- C. 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.
 - 4. Before piping is placed into service, close plug valves and install plugs. Protect plugs and plug valves from corrosion in as specified in Section 09_96_01 - High-Performance Coatings.
- D. Restraining above ground piping:
 - 1. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
 - a. When piping is aboveground or underwater, use mechanical or structural restraints.
 - 2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
 - b. During testing, provide suitable temporary restraints where piping does not require permanent restraints.
- E. 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 Owner of 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.
- F. 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.

- G. 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.

3.03 PIPING SCHEDULE

- A. As indicated in this Section.

PIPING SCHEDULE										
Process Abbrev.	Service	Service Conditions	Nominal Dia. (in)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure (psig)/ Method	Lining	Coating
ASF	Annular Space Fill	Above Ground, Outdoors	All	304L SST	Sch 10	40_05_23.01	Threaded	150/HH	None	None
DR	Drain	Above Ground, Outdoors	All	PVC	Sch 80	40_05_31.17	Solvent Weld/Threaded	Visual	None	ACR-PVC-1
MWD	Monitoring Well Discharge	Above Ground, Outdoors	All	304L SST	Sch 10	40_05_23.01	Threaded	150/HH	None	None
NG	Nitrogen Gas	Above Ground, Outdoors	All	304L SST	Sch 10	40_05_23.01	Threaded	150/HH	None	None
DIQ/ROC	Deep Injection Irrigation Quality / Concentrate	Austenitic and duplex grades of material with PREN greater than 45	All	316L SST	Sch 10	40_05_23.01	Threaded	150/HH	None	None
SPD	Sump Pump Discharge	Above Ground, Outdoors	All	PVC	Sch 80	40_05_31.17	Solvent Weld/Threaded	Visual	None	ACR-PVC-1

PIPING SCHEDULE										
Process Abbrev.	Service	Service Conditions	Nominal Dia. (in)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure (psig)/ Method	Lining	Coating
		Buried	All	PVC	Sch 80	40_05_31.17	Solvent Weld/Threaded	Visual	None	ACR-PVC-1

END OF SECTION

SECTION 40_05_00.03

PIPE IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Pipe identification including the following:
 - 1. Pipe identification by color and legend.
 - 2. Underground warning tape.
 - 3. Tracer wire.
 - 4. Witness markers.
 - 5. Valve identification.

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 01_33_00 - Submittal Procedures.
- B. Submit following:
 - 1. Product data.
 - 2. Samples.
 - 3. Manufacturer's installation instructions.
 - 4. Submit following as specified in Section 01_77_00 - Closeout Procedures:
 - a. Operation and Maintenance Data.
 - b. Warranty.

PART 2 PRODUCTS

2.01 ABOVE GROUND AND IN-CHASE PIPE IDENTIFICATION

- A. Pipe Markers:
 - 1. Manufacturers: One of the following or equal:
 - a. Seton, Opti Code Pipe Markers.
 - b. Lab Safety Supply.
 - c. Marking Services, Inc.
 - 2. Materials:
 - a. Pipe markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

3. Lettering:

Outside Pipe Diameter Including Covering	Lettering Size
Less than 1.5 inches	1/2-inch
1.5 inches to 2 inches	3/4-inch
2.5 inches to 4 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

4. Coating: As specified in Section 09_96_01 - High-Performance Coatings.
5. Pipe identification tags: Aluminum or stainless steel with stamped-in 1/4-inch-high identifying lettering.
6. Pipe identification tag chains: Aluminum or stainless steel.
7. Snap-on markers: Markers with 3/4-inch high letters for 3/4 to 4-inch pipe or covering, or 5-inch high letters for 5-inch or larger pipe or cover:
 - a. Manufacturers: One of following or equal:
 - 1) Brady BradySnap-On B-915.
 - 2) Seton Setmark.

2.02 VALVE AND GATE IDENTIFICATION

- A. Provide valve and gate schedule for each valve and gate in the Work with the following information:
 1. Identification number.
 2. Location.
 3. Type.
 4. Function.
 5. Normal operating position.
- B. Identification tag requirements.
 1. Diameter: 2-inches.
 2. Material:
 - a. Above ground and in-chase applications: 19 gauge aluminum or PVC.
 3. Stamp tags in 1/4-inch high letter:
 4. Provide non-corrosive metal wire suitable for attaching the tag to the operator base.
 5. Secure tags to valve or gate:
 - a. Attach tags in such a way as to allow free and full operation of the valve or gate.
 6. Buried applications with concrete marker: Secure tags to concrete marker.
- C. Submittal requirements:
 1. Submit 2 samples of the type of tag proposed and the manufacturer's standard color chart and letter styles to the Engineer for review.
- D. Manufacturer: The following or equal:
 1. Seton Name Plate Co.

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 01_60_00 - Product Requirements.

3.02 PREPARATION

- A. Prepare and coat surfaces as specified in Section 09_96_01 - High-Performance Coatings.
- B. Prepare surface in accordance with product manufacturer's instructions.

3.03 ABOVE GROUND AND IN-CHASE PIPING IDENTIFICATION

- A. Color code:
 - 1. Paint piping with colors as scheduled in Piping Color Code and Marker Schedule.
- B. Lettering and flow direction arrows:
 - 1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4-inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
 - 2. Provide lettering 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.
- C. Where scheduled, space 4-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.
- D. Label chemical tank fill pipelines at locations which are visible from chemical fill stations.
- E. Metal tags:
 - 1. Where outside diameter of pipe or pipe covering is 5/8-inch or smaller, provide metal pipe identification tags instead of lettering.
 - 2. Fasten pipe identification tags to pipe with chain.
 - 3. Where tags are used, color code pipe as scheduled.

3.04 APPLICATION

- A. Identify piping with legend markers, directional arrow markers, and number markers; use self-adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.
- B. Provide legend markers, directional arrow markers, and number markers where piping passes through walls or floors, at piping intersections and at maximum 15-foot spacing on piping runs.

- C. Provide piping marker letters and colors as scheduled.
- D. 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.

3.05 PIPING COLOR CODE AND MARKER SCHEDULE

Service Fluid	Pipe Color	Marker Legend
Chemical Drain	Charcoal	CHEMICAL DRAIN
Cooling Water	Blue	COOLING WATER
Domestic Cold Water	Light Blue	DOMESTIC COLD WATER
Domestic Hot Water	Light Blue	DOMESTIC HOT WATER
Deionized Water	Blue	DEIONIZED WATER
Drain	Charcoal	DRAIN
Exhaust Gas	Yellow	EXHAUST GAS
Engine Jacket Water	Dark Blue	ENGINE JACKET WATER
Fuel Oil	Orange	FUEL OIL
Grit	Black	GRIT
Instrumental Air	Purple	INSTRUMENTATION AIR
Engine Lube Oil	Red	ENGINE LUBE OIL
Pumped Drain	Charcoal	PUMPED DRAIN
Process Water	Dark Blue	PROCESS WATER
Raw Wastewater	Buff	NONE USED
Return Water	Silver/Grey	RETURN WATER
Sample	Green	FLUID BEING SAMPLED
Sanitary Drain	Charcoal	SANITARY DRAIN
Service Air	Green	SERVICE AIR
Sodium Hypochlorite	Yellow	CHLORINE SOLUTION
Sodium Bisulfite	Yellow	SODIUM BISULFITE SOLUTION
Tank Drain	Charcoal	TANK DRAIN
Vent Pipe	Yellow	VENT PIPE
Washdown Water (W3)	Medium Blue	WASHDOWN WATER

Letters	Color of Pipe	Color of Bands	Color of Letters
Finished or Potable (cold)	Light blue	None	Black
Potable (hot)	Light blue	Red	Black
Non-potable or Raw	Light blue	Dark Gray	Black
Distilled or Demineralized	Light Blue	Black	Black
Service Water (lines downstream from backflow prevention unit)	Dark Blue	White	Red
Sample	Dark Blue	Black	White
Fire Protection	Red	None	Black
Hydrants	Aluminum	None	Black
Filter-to-Waste	Light Brown	None	Black
Wash Water Drain	Light Gray	None	Black
Sewage	Light Gray	None	Black
Solids	Dark Brown	None	White
Scum	Dark Brown	None	White
Drain	Dark Gray	None	White
Sump Pump Pipe Line	Dark Gray	Red	White
Chlorine (gas, liquid, or vent)	Yellow	None	Black
Chlorine (solution)	Yellow	Red	Black
Ferric Chloride	Orange	Yellow	Black
Alum	Orange	Yellow	Black
Ammonia	Yellow	Dark Brown	Black
Auxiliary Chemical	Yellow	Dark Blue	Black
Sulfuric Acid	Yellow	Orange	Black
Sodium Hydroxide	Yellow	Dark Green	Black
Algaecide (Potassium Permanganate, Copper Sulfate)	Orange	White	Black
Polymer	Orange	Dark Green	Black
Polyphosphate	Orange	Dark Gray	Black
Carbon	Black	None	White
Ozone	None	Red	White
Stainless Steel Pipe	White	Red	White
Ozone Off Gas			

Letters	Color of Pipe	Color of Bands	Color of Letters
Stainless Steel Pipe	None	Orange	White
Other Pipe	White	Orange	White
Compressed Air	Light Green	None	Black
Instrument Air	Light Green	Dark Green	Black
Backwash Air (Low Pressure)			
Stainless Steel Pipe	None	None	Black
Other Pipe	Light Green	None	Black
Process Air (Ozone-Low Pressure)			
Stainless Steel Pipe	None	None	Black
Other Pipe	Light Green	None	Black
Laboratory Vacuum	Dark Green	Light Green	Red
Natural Gas	Red	Yellow	White
Refrigerant	Yellow	White	Black
Heating Water (supply)	Light Gray	White	Black
Heating Water (return)	Light Gray	Black	Black
Condenser Water (supply)	Light Gray	Dark Brown	Black
Condenser Water (return)	Light Gray	Red	Black
Chilled Water (supply)	Light Brown	Dark Gray	White
Chilled Water (return)	Light Brown	Red	White

END OF SECTION

SECTION 40_05_00.09
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 40_05_00.01 - 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 01_41_00 - 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 01_41_00 - 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 01_50_00 - 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 01_33_00 - 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 40_05_00.01 - 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:

$$L = S \times D \times P^{1/2} \times 133,200^{-1}$$

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 40_05_00.01 - 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 40_05_06.03

PIPE COUPLINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Pipe couplings for stainless steel piping.

1.02 REFERENCES

- A. American National Standards Institute (ANSI).
- B. American Society of Mechanical Engineers (ASME):
 - 1. B31.1 - Power Piping.
 - 2. B31.9 - Building Services Piping.
- C. American Water Works Association (AWWA):
 - 1. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 2. C207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.
 - 3. C213 - Standard for Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
 - 4. C606 - Standard for Grooved and Shouldered Joints.
- 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. A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - 4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 5. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - 6. A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/9 ksi Minimum Tensile Strength, General Use.
 - 7. A536 - Standard Specification for Ductile Iron Castings.
 - 8. A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 - 9. C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
 - 10. C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

11. C564 - Standard Specification for Rubber Gasket for Cast Iron Pipe and Fittings.
12. C1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
13. D1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
14. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
15. D5926 - Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
16. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
17. F594 - Standard Specification for Stainless Steel Nuts.

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data:
 1. For each product in this Section as applicable:
 - a. Design features.
 - b. Load capacities.
 - c. Material designations by UNS alloy number or ASTM Specification and Grade.
 - d. Data needed to verify compliance with the Specifications.
 - e. Catalog data.
 - f. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

1.04 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. Known acceptable manufacturers are listed by specific products.
- B. Provide references as specified in this Section by specific product.
- C. Manufacturer's representative's requirements as specified in Section 01_75_17 - Commissioning and this Section by specific product.
- D. Gaskets for flexible couplings and flanged coupling adapters:
 1. Provide gasket materials for piping applications as follows:
 - a. Low-pressure and high-pressure air, steam, hot water: EPDM.
 - b. All other piping applications: EPDM

2.02 PIPE COUPLINGS FOR STAINLESS STEEL PIPING

- A. Flexible couplings:
1. Manufacturers: The following or equal:
 - a. Dresser, Inc., Style 38.
 2. Materials:
 - a. Center sleeve and follower flanges: Stainless steel. .
 - b. Bolts and hex nuts:
 - 1) Type 316 stainless steel bolts in accordance with ASTM F593.
 3. Coating and lining: Manufacturer's standard fusion bonded epoxy.
 4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Diameter	Sleeve Length
2-1/2 inch and smaller	Manufacturer's standard
3 inch through 6 inch	7 inch
8 inch through 14 inch	7 inch
Greater than 14 inches	10 inch

PART 3 EXECUTION

3.01 INSTALLATION

- A. In underground and underwater installations, coat the exterior of coupling with a protective coating in accordance with manufacturer's instructions.
- B. Joints and flexible connections shall be installed centered with no angular deflection unless otherwise indicated on the Drawings.
- C. Flexible couplings and flange coupling adapters: Install with gap between pipe ends in accordance with the following table unless a greater gap is indicated on the Drawings. Maximum gap tolerance shall be within 1/8 inch.
1. Install flexible coupling with pipe gap located in middle of center sleeve.
 2. Install flanged coupling adapter with end of plain end pipe in middle of flanged coupling body:

Center Ring Length	Gap Dimension and Tolerance
4 inch through 6 inch	3/8 inch
7 inch	5/8 inch
10 inch and greater	7/8 inch

- D. Provide harnesses (tie-downs) for flexible couplings unless otherwise indicated on the Drawings with a written note.
1. Design harnesses (tie-downs) for the test pressures as specified in the Piping Schedule in Section 40_05_00.01 - Common Work Results for General Piping.

END OF SECTION

SECTION 40_05_23.01
STAINLESS STEEL PIPE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Stainless steel piping.

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.
 3. B16.11 - Forged Fittings, Socket-Welded and Threaded.
 4. B31.3 - Process Piping.
 5. B36.19 - Stainless Steel Pipe.
- B. American Welding Society (AWS):
1. D1.6 - Structural Welding Code - Stainless Steel.
- C. 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. B622 - Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube.
19. B912 - Standard Specification for Passivation of Stainless Steels Using Electropolishing.
20. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 40_05_00.01 - 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 hangers 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 joints.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. 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. Assemble shop-fabricated piping in the field using the joints designed into the piping layout or by using flexible couplings.

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.
- C. Piping material and manufacturing:
1. Provide location of material fabrication and Chemical analysis certificates.
 2. 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
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 $\text{PREN} = \text{Cr}\% + (3.3 \times \text{Mo}\%) + (16 \times \text{N}\%)$		

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 design and shop-fabricate piping sections utilizing any of the following joint types:
 - 1) Flanged 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 flanged coupling adapters or flanged joints.
 - a) Flexible couplings and flanged coupling adapters: Provide stainless steel construction with materials matching the piping system, and conforming to requirements as specified in Section 40_05_06.03 - Pipe Couplings.
 - d. Joints in membrane and reverse osmosis filtration systems:
 - 1) Aboveground piping: flanged.
2. Joints in piping 2 inches in diameter and smaller: screwed with Teflon™ tape thread lubricant as specified in Section 40_05_00.01 - Common Work Results for General Piping.
3. Flanged joints: Conforming to the requirements in accordance with ASME B16.5, Class 150.

G. Gaskets:

1. All other service applications: EPDM, nitrile, or other materials compatible with the process fluid.

H. Bolts for 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. Lubricant for stainless steel bolts and nuts:
 - 1) Chloride-free.
 - 2) Manufacturers: One of the following or equal:
 - a) Huskey FG-1800 Anti-Seize.
 - b) Weicon Anti-Seize High-Tech.

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.
- e. Cleaning (pickling) and passivation:
- 3. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.
- 4. Clean (pickle) and passivate in accordance with ASTM A380 or 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.
- 5. 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 all 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 40_05_00.01 - 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 protection 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 40_05_31.17

POLYVINYL CHLORIDE (PVC) PIPE: SCHEDULE TYPE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Schedule type PVC pipe and fittings.

1.02 REFERENCES

- A. ASTM International (ASTM):
 1. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 2. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 3. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 4. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 5. 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.
 6. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 40_05_00.01 - Common Work Results for General Piping.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect from sunlight, scoring, and distortion.
- B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.
- C. Store and handle 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.
 - 1. Pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:
 - a. Extruded from Type I, Grade 1, Class 12454 material in accordance with ASTM D1784.
 - b. Schedule 80.
 - 2. Fittings: In accordance with ASTM D2467.
 - a. Same material as the pipe and of equal or greater pressure rating.
 - b. Supplied by pipe manufacturer.
 - c. Unions 4 inches and smaller:
 - 1) Use socket end screwed unions.
 - 3. Solvent cement:
 - a. In accordance with ASTM D2564.
 - b. Manufacturers: The following or equal:
 - 1) IPS Corp.
 - a) Primer: Type P70.
 - b) Cement: Type 724.
 - (1) Cement color shall be orange.
 - c. Certified by the manufacturer for the service of the pipe.

2.02 SOURCE QUALITY CONTROL

- A. Meets or exceeds all quality assurance test requirements stated in ASTM D1785.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable.
- B. Provide molded transition fittings for transitions from plastic to metal pipe.
 - 1. Do not thread pipe.
 - 2. Do not use flanged transition fittings unless specifically indicated on the Drawings.
- C. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
- D. Provide serrated nipples for transition from pipe to rubber hose.
- E. Solvent weld joints in accordance with ASTM D2855.

3.02 FIELD QUALITY CONTROL

- A. Test pipe as specified in Section 40_05_00.01 - Common Work Results for General Piping and Section 40_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 40_05_51.01

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. 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 01_33_00 - Submittal Procedures.
- B. Product data:
1. Submit the following information for each valve:
 - a. Valve type, size, pressure rating, Cv factor.
 - b. Coatings.
 - c. Power valve actuators:
 - 1) Information on valve actuator including size, manufacturer, model number, limit switches, mounting; and motor enclosure, seating and unseating torque coefficient, dynamic torque, and bearing friction for calculation of maximum operating torque.
 - 2) Complete wiring diagrams and control system schematics.
 - d. Manual valve actuators:
 - 1) Information on valve actuator including size, manufacturer, model number.
 - e. Certified drawings with description of component parts, dimensions, weights, and materials of construction.
 - 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 01_78_24 - 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 as specified in Section 01_75_17 - Commissioning.
- E. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

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, except for plastic butterfly valves.
 - 1) Plastic butterfly valves shall be flanged per Section 40_05_64 - Butterfly Valves.
 - 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 40_05_00.01 - 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 INTERIOR PROTECTIVE LINING

- A. When specified in the particular valve specification, provide valves with type of protective lining specified in the particular valve Specification.
- B. Apply protective lining to interior, non-working surfaces, except stainless steel surfaces.
- C. Lining types:
 - 1. Fusion bonded epoxy:
 - a. Manufacturers: The following or equal:
 - 1) 3-M Company, ScotchKote 134.
 - b. Clean surfaces in accordance with SSPC SP 7 or SP 10, as recommended by epoxy manufacturer.
 - c. Apply in accordance with manufacturer's published instructions.
 - d. Lining thickness: 0.010 to 0.012-inch, except that:
 - 1) Lining thickness in grooves for gaskets: 0.005-inch.
 - 2) Do not coat seat grooves in valves with bonded seat.
 - e. Quality control:
 - 1) Lining thickness: Measured with a non-destructive magnetic type thickness gauge.
 - 2) Verify lining integrity with a wet sponge-testing unit operating at approximately 60 volts, or as recommended by the lining manufacturer.
 - 3) Consider tests successful when lining thickness meets specified requirements and when no pinholes are found.
 - 4) Correct defective lining disclosed by unsuccessful tests, and repeat test.
 - 5) Repair pinholes with liquid epoxy recommended by manufacturer of the epoxy used for lining.

2. High solids epoxy:
 - a. Product equivalent to high solids epoxy EPX-M-1-PWS as specified in Section 09_96_01 - High-Performance Coatings.
 - 1) Interior: Coat valve interior with manufacturer's equivalent high performance high solids epoxy coating system with a certifiable performance history for the service conditions and as approved by the Engineer. Manufacturer shall provide for approval, coating information sufficient to allow Engineer to assess equivalence to the specified high solids epoxy EPX-M-1-PWS as specified in Section 09_96_01 - High-Performance Coatings.
 - b. Clean surfaces to meet SP-7 or SP-10, or as recommended by coating manufacturer.
 - c. Quality control: After coating is cured, check coated surface for porosity with a holiday detector set at 1,800 volts, or as recommended by coating manufacturer.
 - 1) Repair holidays and other irregularities and retest coating.
 - 2) Repeat procedure until holidays and other irregularities are corrected.

2.04 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 FIELD APPLIED COATING OF VALVE EXTERIOR

- A. Match color and be compatible with manufacturer's coating system and as specified in Section 09_96_01 - High-Performance Coatings.
 - 1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
 - 2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.04 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and 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 40_05_52

SPECIALTY VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Specialty valves.
- B. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

- A. American Society of Civil Engineers (ASCE):
 - 1. 25 - Earthquake-Actuated Automatic Gas Shutoff Devices.
- B. American Society of Mechanical Engineers (ASME):
 - 1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
- C. American Water Works Association (AWWA):
 - 1. C511 - Standard for Reduced Pressure-Principle Backflow-Prevention Assembly.
 - 2. C800 - Underground Service Line Valves & Fittings (Also Included: Collected Standards For Service Line Materials).
- D. ASTM International (ASTM):
 - 1. A48 - Standard Specification for Gray Iron Castings.
 - 2. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
 - 3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
 - 4. A536 - Standard Specification for Ductile Iron Castings.
 - 5. B584 - Standard Specification for Copper Alloy Sand Castings for General Application.
 - 6. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
- E. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves.

- C. Commissioning submittals:
 - 1. Backflow preventer certification.
 - 2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 SURGE RELIEF AND ANTICIPATOR VALVE

- A. Manufacturers: One of the following or equal:
 - 1. Cla-Val Co., Model 52G-03BPY.
 - 2. Or Approved Equal.
- B. Operation:
 - 1. Open and close at a rate needed to eliminate surge accompanying a power failure.
 - 2. Suitable at rated working pressure of 250 PSI, Class 150 DI ASTM A536.
 - 3. Valve will be designed to act as a pressure relief and surge anticipator. It will have a normally closed high pressure pilot designed to open if the pressure exceeds the normal operating pressure while pumping. It will also have a low pressure pilot that is held closed as long as the system is at or above static. If there is a pressure drop, due to a power outage the low pressure pilot will open. This will partially open the main valve, anticipating the returning high wave. The mechanical flow limiter will limit valve opening on the down surge so the valve can reseal when normal system pressure is restored.
 - 4. The main valve will be ductile iron angle pattern design and have stainless trim internals. It will be diaphragm actuated. No pistons actuated valves will be accepted. It will have a one-piece stainless-steel seat. It will have an NSF approved fusion bonded epoxy coating. The main valve will be single chambered and there shall not be any chambers between the flowing line pressure and the area above the single diaphragm. The pilot system will include stainless steel tubing and fittings. The main valve will have a one-piece solid stainless-steel seat. No snap rings will be acceptable. The main valve will be fully guided throughout its stroke by a bearing in the main valve cover and an integral bearing in the seat. The cover studs and nuts will be stainless steel. The cover will have a locating lip. There shall be no pinned covers. The main body will have 150 ANSI flanged ends rated to 250 PSI working pressure. The relief pilot will have a 20-200 psi spring range. The low pressure pilot will have a 20-105 PSI range. When the valve opens on a pressure drop the flow limiter will keep the valve from going fully open. The manufacturer will install a gauge on the inlet for monitoring and start-up.
 - 5. The contractor will install a minimum 3/4" sensing/pilot feed line from the header to the female bell housing on the pilot system for supply pressure and sensing.
 - 6. The manufacturer shall provide a factory trained representative for start-up and training.
 - 7. The manufacturer shall warranty the valve for 3 years from date of shipment.

- C. Design:
 - 1. Pilot valve strainer.
 - 2. Adjustable pilot valve with stainless steel trim.
 - 3. Flanged ends.
 - 4. Valve position indicator.
- D. Materials:
 - 1. Valve body: Cast or ductile iron.
 - 2. Body trim: Bronze.
 - 3. Diaphragm: EPDM.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install as specified in Section 40_05_51.01 - Common Work Results for Valves in accordance with manufacturer's published instructions.
- B. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade or top of containment wall.
- C. Plastic body diaphragm valves for sodium hypochlorite service:
 - 1. When valves are installed horizontally, install valves with valve stem position rotated as necessary such that no internal valve obstruction prevents the passage of vapors traveling along the top of adjacent piping from traveling through the valve.
- D. Backflow preventers:
 - 1. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade or top of containment wall.
 - 2. Install with sufficient side clearance for access for testing and maintenance.

3.02 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and this Section.
- B. Manufacturer services:
 - 1. Provide certificates:
 - a. Manufacturer's Certificate of Installation and Functionality Compliance.
 - 2. Manufacturer's Representative onsite requirements:
 - a. For the following valves:
 - 1) Surge relief anticipator valve.
 - b. Installation: 1 trip, 1 day minimum.
 - c. Functional Testing: 1 trips, 1 day minimum each.
 - d. Training:
 - 1) Maintenance: 2 hours per session, 1 sessions.
 - 2) Operations: 2 hours per session, 1 sessions.

- C. Functional testing:
 - 1. Surge relief and anticipator valves:
 - a. Test witnessing: Witnessed.
 - b. Conduct pressure and leak test as specified in Section 40_05_51.01 - Common Work Results for Valves.

END OF SECTION

SECTION 40_05_57.13

MANUAL ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Valve Actuators.

1.02 REFERENCES

- A. American Water Works Association (AWWA).

1.03 DEFINITIONS

- A. NEMA:
 - 1. Type 4X enclosure in accordance with NEMA 250.
 - 2. Type 7 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

- A. Shop drawings: Include shop drawings and product data with associated gate or valve as an integrated unit.

1.05 QUALITY ASSURANCE

- A. Provide valve actuators integral with valve or gate, except for valve actuators utilizing T-wrenches or keys, and portable gate actuators intended to operate more than 1 valve.
- B. Provide similar actuators by 1 manufacturer.

1.06 MAINTENANCE

- A. Extra materials:
 - 1. Key operated valve keys or wrenches: Furnish a minimum 4 keys with 4-foot shafts and 3-foot pipe handles or wrenches with 4-foot shafts and 3-foot handles for operating key operated valves.

PART 2 PRODUCTS

2.01 VALVE ACTUATORS

- A. Valve actuators:
 - 1. Manual actuators:
 - a. Material: Type 316 stainless steel.

- b. Design: Hand lever.
 - c. Spring release handle: 12-inch.
 - d. Notch plate: 10 position.
 - e. Secure with mounting bolts.
 - f. Locking device so that valve can be locked in any position with a wing nut.
- B. Provisions for alternate operation: Where specified or indicated on the Drawings, position and equip crank or handwheel operated geared valve actuators or lifts for alternate operation with tripod mounted portable gate actuators.
- C. Operation: Counterclockwise to open with suitable and adequate stops, capable of resisting at least twice normal operating force to prevent overrun of valve or gate in open or closed position.
- D. Open direction indicator: Cast arrow and legend indicating direction to rotate actuator on handwheel, chain wheel rim, crank, or other prominent place.
- E. Buried actuator housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between actuator housing and valve body so that no moving parts are exposed to soil; provide actuators with 2-inch square AWWA operating nut.
- F. Worm gear actuators: Provide gearing on worm gear actuators that is self-locking with gear ratio such that torque in excess of 160 foot-pounds will not need to be applied to operate valve at most adverse conditions for which valve is designed.
- G. Traveling nut actuators: Capable of requiring maximum 100 foot-pounds of torque when operating valve under most adverse condition; limit stops on input shaft of manual actuators for fully open and closed positions; non-moving vertical axis of operating nut when opening or closing valve.

2.02 ACCESSORY EQUIPMENT

- A. Wall brackets or haunches: As indicated on the Drawings.
- B. Stems: Stainless steel; sized to match output of actuator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.
- C. Stem couplings: Stainless steel; internally threaded to match stem; lockable to stem by set screw.
- D. Stem guides: Cast-iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with wall bracket; adjustable in 2 directions.
- E. Wall brackets: Cast-iron, capable of withstanding output of actuator, adjustable in 2 directions.
- F. Stem stuffing boxes: Cast-iron, with adjustable gland and packing.
- G. Fasteners: Type 316 stainless steel.

- H. Anchor bolts: As specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry except that the material shall be Type 316 stainless steel.
- I. Geared valve actuators: Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40-pound pull at handwheel or chain wheel rim.
- J. Accessory equipment for valves and gates requiring remote actuators: Operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

PART 3 EXECUTION

3.01 SCHEDULES

- A. Geared actuators: Provide geared actuators for following valves:
 - 1. Butterfly valves larger than 6 inches, nominal size, on liquid service.
- B. Handwheel actuators: Provide handwheel actuators for valves mounted 6 feet or less above floors.

END OF SECTION

SECTION 40_05_57.24
ELECTRIC ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Electric motor-driven actuators for valves and gates as identified in the valves and gates schedule as EAM, EDM, or EDR, except for specialty actuators specified with individual valves.

1.02 REFERENCES

- A. American Water Works Association (AWWA):
 - 1. C504 - Standard for Rubber-Seated Butterfly Valves.
 - 2. C542 - Standard for Electric Motor Actuators for Valves and Slide Gates.
- B. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

- A. NEMA:
 - 1. Type 4X enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures and Section 46_05_10 - Common Work Results for Mechanical Equipment.
- B. Provide a complete list/schedule of all actuators being provided with their associated tag names as indicated on the design drawings and/or specifications, service process area and the size of the valve they are actuating.
- C. Product data:
 - 1. Electrical ratings:
 - a. Voltage and number of phases.
 - b. Starting and running current.
 - c. Voltage levels and source for control and status.
 - 2. Description of integral control interface.
 - 3. Environmental ratings, including NEMA enclosure rating and submergence capabilities.
 - 4. Gear ratios for both manual and motorized actuation.
 - 5. Opening and closing directions.
 - 6. Allowable starts per hour.
 - 7. List of all included options and accessories.
 - 8. Full travel times.
 - 9. Gearbox data including gear ratio, and gearbox efficiency.

- D. Shop drawings:
 - 1. Wiring diagrams:
 - a. Include all options and expansion cards furnished with each actuator.
 - 2. Dimensioned drawings of each valve and actuator combination.
 - 3. Dimensioned drawings of each valve gearbox.
 - 4. Electric motor data.
- E. Calculations:
 - 1. Operating torque.
 - 2. Maximum torque calculations for seating and unseating.
 - 3. Maximum operating torque at starting and normal operation.
 - 4. Signed by Professional Engineer.
- F. Provide draft vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Manuals:
 - 1. Include a list of all configurable parameters, and the final values for each.
 - 2. Include a troubleshooting chart covering the complete valve and controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.
- G. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 - a. Affidavit in accordance with AWWA C542.
 - 2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.
- H. Project closeout documents:
 - 1. Provide final vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Manuals.

1.05 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers for lines 4 inch and larger:
 - 1. One of following or equal:
 - a. Rotork Controls Inc. IQ3 Range:
 - 1) IQ for multi-turn applications.
 - 2) IQT for quarter-turn applications.
 - b. Limitorque Corp.:
 - 1) Accutronix MX for multi-turn applications.
 - 2) Accutronix QX quarter-turn applications.

2.02 CHARACTERISTICS FOR ACTUATORS ON LINES 4 INCHES AND LARGER

- A. Provide actuators complete and operable with all components and accessories required for operation.
- B. Power supply:
 - 1. Voltage and phases as indicated in the Motorized Actuator Schedule.
 - 2. Valve or gate motion independent of power supply phase rotation.
 - 3. Provide an internal backup power source or mechanical indicator to maintain settings and track valve position when main power is off.
 - 4. The actuators shall incorporate all major components such as the motor, starter, local controls, terminals, etc. housed within a self-contained, sealed enclosure.
- C. Size actuator to move gates or valves from full open to closed position within the time indicated in the Motorized Actuator Schedule:
 - 1. If an operating time is not indicated on the Motorized Actuator Schedule, size the actuator to move gates or valves at minimum 12 inches per minute under maximum load. Measure rate of closure for valves at maximum diameter of disc, plug, or ball.
 - 2. Size actuators so that gear boxes are not required where possible.
- D. Control interface:
 - 1. Configuration:
 - a. Provide a non-intrusive, non-contacting interface for configuring all input and output settings, control values, ranges, torque switch settings, valve positions switch settings, and options.
 - 1) Configurable from a handheld configuring tool or input devices on the actuator.
 - 2. Local interface, integral to actuator:
 - a. Non-intrusive, non-contacting selector switches:
 - 1) LOCAL-STOP-REMOTE:
 - a) Motor actuator operation is prevented with the switch in STOP.
 - 2) OPEN-CLOSE:
 - a) Controls the valve when LOCAL-STOP-REMOTE is in LOCAL.
 - b) Spring return to center.
 - c) Configurable between maintained (actuator runs until end of travel, high torque, or a LOCAL-STOP-REMOTE is switched to STOP) and momentary (actuator stops when lever is released).
 - b. Local display:
 - 1) Valve fully open and fully closed indicators.
 - 2) Numerical display showing actual valve or gate position in percent of travel.
 - 3. Control inputs:
 - a. Capable of using 120 VAC or 24 VDC inputs.
 - b. Controls the valve when LOCAL-STOP-REMOTE is in REMOTE.
 - c. Isolated inputs capable of operating from external control voltage source or internal power supply:
 - 1) Furnish 120 VAC or 24 VDC control power supplies within the actuator.

- d. Provide the following inputs:
 - 1) OPEN.
 - 2) CLOSE.
 - 3) STOP.
- e. OPEN and CLOSE inputs configurable between maintained (actuator runs until end of travel, high torque, or a STOP input) and momentary (actuator stops when command is removed).
- 4. Status outputs:
 - a. Monitor relay output: Dry contact, normally closed, opens when actuator is not in REMOTE or in the event of any internal fault or alarm condition.
 - b. Dry contact outputs configured for the functions indicated on the Drawings. Provide the following outputs for all actuators:
 - 1) Fully closed.
 - 2) Fully open.
 - 3) LOCAL-STOP-REMOTE in REMOTE position.
 - c. All output contacts rated for 5 amps, 120 VAC, and 24 VDC.
- 5. Analog input:
 - a. Provide a 4-20 milliampere analog input for analog modulating valves when indicated on the Drawings.
 - b. Modulate valve to maintain position based on analog input value.
 - c. Maximum input impedance 250 ohms.
- 6. Analog output:
 - a. Provide an isolated 4-20 milliampere analog output when indicated on the Drawings.
 - 1) Loop power sourced from the actuator power supply.
 - 2) Capable of driving into a load up to 500 ohms.
 - 3) Output proportional to process value(s) indicated on the Drawings.
 - 4) Valve position.
- E. Features:
 - 1. Time delay on reversal: Incorporate time delay between stopping actuator and starting in opposite direction to limit excessive current, torque, and heating from instantaneous reversal.
 - 2. Data logging:
 - a. Store diagnostic data and reference data.
 - b. Time-stamped historical operating data, including number of operations and most recent operations.
 - c. Torque profiles showing actual torque at each valve position through the operating range.
 - 1) Store reference data (recorded during commissioning) and data from last operation.
 - 3. Provide display of logged data on the actuator, or provisions to download to a personal computer.
- F. Materials:
 - 1. Construct motorized actuators of materials suitable for the environment in which the valve or gate is to be installed.

G. Components:

1. Motors:
2. Specifically designed for valve actuator service with high starting torque, totally enclosed non-ventilated construction.
3. Torque ratings equal to or greater than that required for valve seating and dynamic torques with a 25 percent factor of safety.
 - a. Design requirements for rubber-seated AWWA butterfly valves:
 - 1) Design actuators for maximum gate or valve operating torque, in accordance with and using safety factors required in AWWA C504 and AWWA C542.
 - a) Valve actuator torque requirement for open-close service: Not less than the required valve-seating and dynamic torques under design operating conditions in accordance with AWWA C504.
 - b) Valve actuator torque requirement for modulating service: Not less than twice the required valve dynamic torque under design operating conditions in accordance with AWWA C504.
 - b. Design requirements for slide gates, gate valves, knife gate valves, globe valves, and diaphragm valves:
 - 1) Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C542.
 - 2) Design for the maximum torque and thrust running load over the full cycle.
 - 3) Maximum torque or thrust rating: The actuator stall torque or maximum thrust output shall not exceed the torque or thrust capability of the valve or gate, as determined by the valve or gate manufacturer.
4. Capable of being removed and replaced without draining the actuator gear case.
5. Motor bearings shall be amply proportioned of the anti-friction type and permanently lubricated.
6. Rated for operating under the following conditions without exceeding temperature limits with ambient temperature of 40 degrees Celsius.
 - a. Continuous operation for 15 minutes or twice the open-to-close operating time (whichever is greater) at normal operating torque or 33 percent of maximum torque (whichever is greater).
 - b. 60 starts per hour for open/close service or 1,200 starts per hour for modulating service.
7. Provide the following motor protection features:
 - a. Jammed valve (no valve motion detected through a time delay).
 - b. High motor temperature (sensed by an embedded thermostats).
 - c. High torque.
 - d. Single phasing protection.

H. Enclosures:

1. Actuator housing ratings as indicated in the Motorized Actuator Schedule.
2. Stainless steel external fasteners.

3. Provide o-ring seals for each of the following areas:
 - a. Between the terminal compartment and the internal electrical elements.
 - b. Between the mechanical and electrical portions to protect from the ingress of oil, and to protect the mechanical components of oil from dust and moisture when the electrical terminal is open.
 4. Provide the following minimum enclosure ratings:
 - a. NEMA Type 4X enclosure for general applications.
- I. Position sensing:
1. Electronic and adjustable using a solid-state encoder wheel.
 - a. Mechanical limit switches and potentiometers are not acceptable.
 2. Capable of retaining position and monitoring valve or gate motion when valve is manually actuated and when main power is not present.
 3. Valve range and position switch outputs field adjustable.
- J. Torque sensing:
1. Torque shutdown setting: 40 percent to 100 percent rated torque:
 - a. Adjustable in 1 percent increments.
 2. Torque display: 0 to 100 percent-rated torque.
 3. Capable of interrupting control circuit during both opening and closing and when valve torque overload occurs.
 4. Electrical or electronic torque sensing:
 - a. Extrapolating torque from mechanically measured motor speed is not acceptable due to response time.
 5. Independent of variations in frequency, voltage, or temperature.
 6. The actuator shall store actual operational torque curves for retrieval by plant maintenance staff.
 7. Provide a temporary inhibit of the torque sensing system during unseating or during starting in mid-travel against high inertia loads.
 8. Provide visible verification of torque switch status without any housing disassembly.
- K. Manual actuators:
1. Hand wheel for manual operation.
 - a. Maximum 80 - pound pull on rim when operating gate or valve under maximum load.
 - b. Provide pull chain when motorized actuator is located more than 6 feet above floor surface.
 - 1) Chain shall be of sufficient length to reach approximately 4 feet above the operating level.
 - 2) Where the chain obstructs an aisle or walkway, provide holdback or other means to ensure chain does not create a nuisance or hazard to operating personnel.
 2. Declutch lever: Padlockable, capable of mechanically disengaging motor and related gearing and freeing hand wheel for manual operation.
- L. Gearing: Hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set.
1. Accurately cut to ensure minimum backlash.

- M. Bearings:
 - 1. Anti-friction bearing with caged balls or rollers throughout.
 - 2. Sealed-for-life type thrust bearings housed in a separate thrust base.
- N. Drive bushing:
 - 1. Easily detachable for machining to suit the valve stem or gearbox input shaft.
 - 2. Positioned in a detachable base of the actuator.
- O. Lubrication:
 - 1. Provide totally enclosed actuator gearing with oil or grease filled gear case suitable for operation at any angle.
 - 2. Actuators requiring special or exotic lubricants are not acceptable.

2.03 ACCESSORIES

- A. Software:
 - 1. Furnish PC-based diagnostic and configuration software to display diagnostic data and configure actuators.
 - 2. Provide software communications to the valve actuator and handheld setting tool using Bluetooth wireless or IrDA infrared communications.
 - a. Provide all accessories and drivers required for operation and communications with a standard personal computer running Microsoft Windows.

2.04 SPARE PARTS AND SPECIAL TOOLS

- A. As specified in Section 01_60_00 - Product Requirements.
- B. Spare parts:
 - 1. Provide the following (minimum 10 percent of total number of actuators of each model type furnished, but not less than 1 for each model of actuator furnished):
 - a. Stem nut.
 - b. Worm shaft subassembly.
 - c. Drive sleeve subassembly.
 - d. Complete actuator seal kit.
 - e. Actuator gearbox oil (sufficient quantity to fill 4 gearboxes).
 - f. Encoder.
 - g. Control module.
 - 2. Provide 1 spare motor for each size motor furnished.
- C. Setting tool:
 - 1. Provide a handheld setting tool capable of non-intrusive calibration and interrogation of the actuator.
 - a. Furnish 1 setting tool for every 10 actuators.
 - b. Capable of communicating with PC-based configuration software and transferring the following in either direction between the computer and programmer and setting tool, and between the setting tool and actuator.
 - c. Actuator configurations:
 - 1) Capable of storing up to 10 different configurations.

- d. Diagnostic data:
 - 1) Capable of storing 4 complete sets of diagnostic data.

PART 3 EXECUTION

3.01 GENERAL

- A. As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- B. Position visual indicators so that they are most easily visible.

3.02 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning, Section 46_05_94 - Mechanical Equipment Testing, and this Section.
- B. Manufacturer services:
 - 1. Provide certificates:
 - a. Manufacturer's Certificate of Source Testing:
 - 1) Proof-of-Design and Performance Test Reports in accordance with AWWA C542.
 - b. Manufacturer's Certificate of Installation and Functionality Compliance.
 - 2. Manufacturer's Representative on-site requirements:
 - a. Installation: 2 trips, 2-day minimum each.
 - b. Functional testing: 2 trips, 2-day minimum each.
 - 3. Training:
 - a. Maintenance: 4 hours per session, 2 sessions.
 - b. Operation: 2 hours per session, 2 sessions.
- C. Source testing:
 - 1. Design and Performance Test Reports in accordance with AWWA C542.
 - 2. Test each actuator with a simulated load.
 - a. Simulate a typical valve load.
 - 3. Electrical Instrumentation and Controls:
 - a. Test witnessing: not witnessed.
 - b. Conduct testing as specified in Section 40_90_00 - Instrumentation and Control for Process Systems.
- D. Functional testing:
 - 1. Installed actuator:
 - a. Test witnessing: Witnessed.
 - b. Conduct Level 2 General Equipment Performance Tests.
 - c. Conduct Level 2 Vibration Tests.
 - d. Conduct Level 2 Noise Tests.
 - 2. Electrical Instrumentation and Controls:
 - a. Test witnessing: Witnessed.
 - b. Conduct testing as specified in Section 40_90_00 - Instrumentation and Control for Process Systems.

3.03 MOTORIZED ACTUATOR SCHEDULE

- A. Provide all actuators indicated on the Drawings:
 - 1. Major process actuators are listed in the Intelligent Actuator Schedule in this Section. The Motorized Actuator Schedule does not include all number and types of actuators required for the Project.
- B. Abbreviations relating to type:
 - 1. BFV = Butterfly Valve.
- C. Abbreviations relating to actuator type:
 - 1. O/C = Open and Close Service.
 - 2. MOD = Modulating Service.
- D. Abbreviations relating to controls:
 - 1. PA = Profibus PA.
 - 2. DP = Profibus DP.
 - 3. DN = DeviceNet.
 - 4. FF = Foundation Fieldbus H1.
 - 5. MB = Modbus RTU (RS-485).
 - 6. NET = Manufacturer's proprietary network.
 - 7. A = Analog (4-20 mA) control, modulating duty.
 - 8. D = Discrete control, modulating duty.
 - 9. D-O/C = Discrete Open/Close.

END OF SECTION

INTELLIGENT ACTUATOR SCHEDULE									
Tag Number	Description	Reference DWG	Type	Size	Actuator Type	NEMA Rating	Voltage/ Phase/ Hz	Controls	Notes
EDR-01	Deep Injection Well 1	00N01	PV	24"	MOD	NEMA 4X	480/3/60	A	
EDR-02	Deep Injection Well 2	00N01	PV	24"	MOD	NEMA 4X	480/3/60	A	

SECTION 40_05_62

PLUG VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Non-lubricated plug valves.
 - 2. Lubricated plug valves.
 - 3. Multi-port plug valves.
- B. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

- A. American Water Works Association (AWWA):
 - 1. C517 - Resilient-Seated Cast Iron Eccentric Plug Valves.
 - 2. C606 - Grooved and Shouldered Joints.
- B. ASTM International (ASTM):
 - 1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. A536 - Standard Specification for Ductile Iron Castings.

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures and 40_05_51.01 - Common Work Results for Valves.
- B. Product data.
- C. Shop drawings.
- D. Calculations.
- E. Vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Data.
- F. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning:
 - a. Interior coating.
 - 2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

- A. As specified in Section 40_05_51.01 - Common Work Results for Valves.

2.02 NON-LUBRICATED PLUG VALVES

- A. Manufacturers: One of the following or equal:
 - 1. DeZurik, "PEC".
 - 2. Clow Valve.
 - 3. Milliken Valve, Model 600/601.
- B. Design:
 - 1. Type: Non-lubricated eccentric type, in accordance with AWWA C517.
 - 2. Plug face: Resilient material that operates satisfactorily at a temperature of 180 degrees Fahrenheit continuous and 215 degrees Fahrenheit intermittent, except for valves in compressed air or digester gas service.
 - a. Valves in compressed air service: Resilient material suitable for continuous duty at 250 degrees Fahrenheit.
 - b. Valves in digester gas service: Resilient material suitable for petroleum or digester gas at continuous duty at 180 degrees Fahrenheit.
 - 3. Compression washer: Provide flat compression washer made of Teflon™, or of a material having equal physical characteristics on valve stem between plug and bonnet.
 - 4. Stem seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
 - 5. Grit excluders: Provide PTFE grit excluders at upper plug journals to prevent entry of foreign solids in bearing area.
 - 6. Clearly mark valves to indicate their open and closed positions.
 - 7. Provide valves with ends as required by piping details indicated on the Drawings.
- C. Materials:
 - 1. Body and plug: stainless steel, with plug face of EPDM material suitable for the intended service as specified under paragraph "Design" above.
 - 2. Body seats in valves 3 inch size and larger: Provide with overlay of not less than 90-percent nickel and minimum thickness of 1/8-inch on surfaces contacting the plug face.
 - 3. Stem bearing and bottom bearing: Type 316 stainless steel
 - 4. Internal parts, except the body and plug: Type 316 stainless steel .
 - 5. Exposed nuts, bolts, and washers: Zinc plated. Exception: Exposed nuts, bolts, and washers for buried service: Stainless steel.

2.03 VALVE OPERATORS

- A. Furnish valves with an operating wrench or worm gear operator:
 - 1. Equip valves 4 inch nominal size and smaller with a lever operator.
 - 2. Equip valves 6 inch nominal size and larger with a worm gear operator.

2.04 COATING

- A. Coat and test interior metal surfaces as specified in Section 40_05_51.01 - Common Work Results for Valves.
- B. Field applied coating of valve exterior:
 - 1. Match color and be compatible with manufacturer's coating system and as specified in Section 09_96_01 - High-Performance Coatings.
 - a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
 - b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.05 SHIPMENT, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

- A. As specified in Section 01_60_00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves as specified in Section 40_05_51.01 - Common Work Results for Valves and the manufacturer's instructions.
 - 1. Unless differently indicated on the Drawings install valves so that in the closed position the pressure in the pipeline applies a seating head on the valves.
 - 2. Install valves so that in the open position the plug is located in the top half of the valve body.
- B. For valves requiring lubrication: Lubricate and fill extended lubricant pipes with lubricant suitable for service intended.

3.02 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and this Section.
- B. Manufacturer services:
 - 1. Provide certificates:
 - a. Manufacturer's Certificate of Installation and Functionality Compliance.

- B. Functional testing:
 - 2. Valves:
 - a. Test witnessing: Witnessed.
 - b. Conduct pressure and leak test as specified in Section 40_05_51.01 - Common Work Results for Valves.

END OF SECTION

SECTION 40_05_63

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Ball valves.
- B. As specified in Section 40_05_51.01 - 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 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves:
- C. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - 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.

2.02 METAL BODY BALL VALVES – FULL PORT (BAV00)

- A. Metal Body Ball Valves, 6-Inch Size and Larger:
 - 1. Manufacturers: One of the following or equal:
 - a. Crane ChemPharma Energy.
 - b. DeZURIK/APCO.
 - c. Henry Pratt Company.
 - 2. General:
 - a. Type: Non-lubricated, metal seated and capable of sealing in either flow direction.
 - b. In accordance with AWWA C507.
 - c. Stem packing: Manually adjustable while valve is under pressure.
 - d. ASME B16.1, Class 125 flanged ends.
 - 1. Materials:
 - a. Valves in stainless steel piping: Stainless steel body, material type to match piping material as specified in Section 40_05_00.01 - Common Work Results for General Piping.
 - b. Ball: To match pipe material.
 - c. Seats: PTFE.
 - d. Stem seals: PTFE or Viton™.
 - e. Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
 - 2. Valve actuator:
 - a. Manually operated valves: Self-locking worm gear type actuator with position indicator. Permanently lubricate gearing. Provide adjustable screws to stop travel at both open and closed positions.

2.03 PLASTIC BODY BALL VALVES

- 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.
 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.
 2. Seats: PTFE (Teflon™).
 3. O-rings: Match gasket material of corresponding piping system listed in the Piping Schedule.
- D. 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 Section 01_75_17 - Commissioning and 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 40_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 40_05_64

BUTTERFLY VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Butterfly valves:
 - 1. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME):
 - 1. B16.1 - Cast 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.
- B. American Water Works Association (AWWA):
 - 1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
 - 2. C504 - Rubber-Seated Butterfly Valves.
 - 3. C540 - Standard for Power-Actuating Devices for Valves and Sluice Gates.
 - 4. C550 - Protective Interior Coatings for Valves & Hydrants.
 - 5. C606 - Standard for Grooved and Shouldered Joints.
- C. ASTM International (ASTM):
 - 1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for Higher-Temperature Service.
 - 3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
 - 4. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - 5. A395 - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 - 6. A479 - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
 - 7. A515 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate - and Higher-Temperature Service.
 - 8. A516 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower-Temperature Service.
 - 9. A536 - Standard Specification for Ductile Iron Castings.
 - 10. A564 - Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - 11. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
 - 12. A890 - Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application.

13. B462 - Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
 14. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 15. B691 - Standard Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Rod, Bar, and Wire.
 16. D429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrate.
- D. Compressed Gas Association (CGA):
1. Standard G-4.1 - Cleaning Equipment for Oxygen Service.
- E. United States Code of Federal Regulations (CFR):
1. 21 - Food and Drugs.

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves.
1. For general purpose AWWA butterfly valves, include description of the method of attachment of the disc edge to the valve disc.
 2. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves comply with all provisions in accordance with AWWA C550.
- C. Commissioning submittals:
1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Design requirements:
1. General purpose AWWA butterfly valves:
 - a. Design standard: Provide valves designed and manufactured in accordance with AWWA C504.

- b. Class:
 - 1) Provide butterfly valves in accordance with AWWA Class 150B, unless otherwise specified.
 - 2) Provide butterfly valves in accordance with AWWA Class 250B in piping systems with test pressure greater than 150 pounds per square inch and less than 250 pounds per square inch.
 - 2. High pressure butterfly valves:
 - a. Piping systems designed for operating pressures greater than 250 pounds per square inch and less than 450 pounds per square inch: Provide ASME B16.5, Class 300 high pressure valves.
 - 3. Industrial class butterfly valves:
 - a. Industrial class butterfly valves capable of 150 pounds per square inch leak tight shut off.
 - 4. Stainless steel butterfly valves:
 - a. Stainless steel butterfly valves capable of a minimum of 100 pounds per square inch leak tight shut off and with special cleaning, packaging, and handling.
- B. Design requirements for all butterfly valves with power actuating devices:
 - 1. Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C540, using the following values:
 - a. Maximum water velocity: 16 feet per second with valve fully open.
 - b. Maximum pressure differential across the closed valve equal to the pressure class designation.
 - c. Coefficient for seating and unseating torque, dynamic torque, and bearing friction in accordance with valve manufacturer's published recommendations.
 - 2. Valve disc: Seat in an angular position of 90 degrees to the pipe axis and rotate an angle of 90 degrees between fully open and fully closed positions:
 - a. Do not supply valves with stops or lugs cast with or mechanically secured to the body of the valve for limiting the disc travel.
 - 3. Unacceptable thrust bearings: Do not provide valves with thrust bearings exposed to the fluid in the line and consisting of a metal bearing surface in rubbing contact with an opposing metal bearing surface.
- C. Performance requirements:
 - 1. Tight shutoff at the pressure rating of the valve with pressure applied in either direction.
 - 2. Suitable for the following service conditions:
 - a. Throttling.
 - b. Frequent operation.
 - c. Operation after long periods of inactivity.
 - d. Installation in any position and flow in either direction.

2.02 STAINLESS STEEL BUTTERFLY VALVES

- A. Manufacturers: One of the following or equal:
 - 1. DeZURIK HP.
 - 2. Neles-Jamesbury Inc., 815LO.

3. Tyco-Keystone K-LOK Figure 362.
4. Bray Controls, Series 40.
5. Crane Flowseal High Performance Butterfly Valve.

B. Stainless steel alloys:

1. For the purposes of these specifications the Pitting Resistance Equivalent Number (PREN) is defined as PREN equals chromium percent plus (3.3 times molybdenum percent) plus (16 times nitrogen percent).
2. PREN values and ASTM methods for material manufacture are as follows:

UNS#	ALLOY	Cr%	Mo%	N%	PREN	ASTM Method		
						Valve Body	Valve Disc	Valve Shaft
N10276	C-276	14.5-16	15-17	-	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	-	46			
N08366	AL6XN	20-22	6-7	-	40	A743 or B462	A743 or B462	B691
N06985	Alloy G	21-23.5	5.5-7.5	-	39			
S32760	Zeron 100	24-26	3-4	0.2-0.3	37			
S32205	Alloy 2205	22-23	3-3.5	0.14-0.20	34	A890, Gr 4A	A890, Gr 4A	A890, Gr 4A
N08904	904L	19-23	4-5	-	32			
S31726	317LMN	17-20	4-5	0.1-0.2	32			
N08825	Alloy 825	19-23.5	2.5-3.5	-	27			
S31603	316	16-18	2-3	-	23	A351, CF8M	A351, CF8M	A479

C. Valve body:

1. Material: Same material as the pipe the valve is connected to.
2. Body design: Lugged style body with drilled and tapped bolt holes in accordance with ASME B16.1, Class 125, Class 150, and Class 300.

D. Disc:

1. Offset disc.
2. Material: Same as valve body.

E. Shaft and bearings:

1. Shaft: Same as valve body.
2. Shaft bearings: Self-lubricating sleeve type, Teflon™ with stainless steel or fiberglass backing.

F. Disc pins: Secure valve disc to shaft by means of solid, smooth-sided, taper or dowel pins. Disc pin material shall be the same as the valve body.

1. Extend pins through shaft and mechanically secure in place.

G. Seats:

1. Material: Teflon™, or Teflon™ with titanium back-up ring.
2. Seat retainer insert: Same material as the valve body.

- H. Valve shaft packing:
 - 1. Adjustable V-ring Teflon™ packing with Type 316 stainless steel packing gland.
- I. Valve actuator:
 - 1. Torque Nut: Type 316 stainless steel.
 - 2. Lever Actuators: Type 316 stainless steel.
 - 3. Gear Actuators: All cast iron.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves with valve shafts horizontal, unless a vertical shaft is required to suit a particular installation, and unless a vertical shaft is indicated on the Drawings.
- B. Install pipe spools or valve spacers in locations where butterfly valve disc travel may be impaired by adjacent pipe lining, pipe fittings, valves, or other equipment.

3.02 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and 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 40_05_51.01 - Common Work Results for Valves.

END OF SECTION

SECTION 40_05_65.01

GATE VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Knife gate valves.
- B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME):
 - 1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 inch Standard.
 - 2. B16.47 - Large Diameter Steel Flanges: NPS 26 through NPS 60 inch Standard.
- B. American Water Works Association (AWWA):
 - 1. C515 - Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Services.
 - 2. C 550 - Protective Interior Coatings for Valves and Hydrants.
- C. ASTM International (ASTM):
 - 1. B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

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. Provide written confirmation from valve manufacturer that valves can be installed as shown on the Drawings.
 - 2. Provide written confirmation from the valve manufacturer that valves materials are suitable for handling reverse osmosis concentrate.
- C. Commissioning submittals: For valves larger than 16 inches:
 - 1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

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

PART 2 PRODUCTS

2.01 KNIFE GATE VALVES (GV60)

- A. Manufacturers: One of the following or equal:
 - 1. Non-AIS compliant valves:
 - a. Dezurick KGC-ES series.
 - b. ITT Fabri-Valve
 - c. Pentair, Figure
- B. Design:
 - 1. Valve shall be bi-directional knife gate, metal seated, bonneted with a top mounted packing system to provide a tight stem seal and a Back-Seat ring to allow repacking the valve under pressure.
 - 2. Size and configuration: Indicated on the Drawings.
 - 3. Cold working pressure valve rating shall meet or exceed MSS SP-81 Knife Gate Valves. Valves shall be 150 psi (1030 kPa) for 2-24" (50–600mm) and 50 psi (345 kPa) for sizes above 24" (600mm). Full round port, metal or resilient seated, raised face design.
 - 4. Flanged wafer design drilled and tapped to ASME Class 125/150 standard. Flanges shall be raised face with spiral serrated finished stainless steel gasket surface. Face-to-face dimension shall meet MSS SP-81 for knife gate valves ASME B16.5 class 150, 2 to 24 inches or ASME 16.47 Series A class 150, 26 to 48 inches. Drilling shall be in accordance with ASME B16.5 class 150, 2-24" (50-600mm); ASME B16.47 Series A class 150 above 24" (600mm).
 - 5. Rounded gate with beveled edge, finish-ground to 32 RMS, minimum, on both sides. The bottom edge shall have a 45 degree beveled knife edge. The gate shall be guided over the full stroke. The gate shall be fully wedged at the top and bottom of the port. Gate shall be supported with rollers and scrapers for side installation.
 - 6. Body to incorporate guides and jams to assist in seating.
 - 7. Bonnet shall be pressure-retaining type that fully encloses the gate. The bonnet shall be rated at the same pressure as the valve body and shall not include any type of internal gate packing or gate wiper. Body cladding and face rings shall be fully welded to the body – "floating" body liners are not acceptable.
 - 8. Valve inside port diameter shall conform to MSS SP-81 requirements.
 - 9. Packing system shall consist of multiple layers of packing and allow the packing to be replaced under pressure without disassembling the valve or removing the actuator. The packing gland shall be machined on the bottom to mate with the machined stem Back-Seat ring. The selected multiple ring packing set shall be for wet service. The fasteners shall be stainless steel.
 - 10. Materials:
 - a. Body and Bonnet:
 - b. All wetted parts of the body and bonnet shall be of the same material as the connecting pipe including fasteners, Exterior flanges and stiffeners shall be fabricated stainless steel. Flush and drain ports, if specified, shall be of the same material as the wetted parts.
 - c. Wetted components (including gate): Same material as connecting pipe.

- d. Seat: shall be metal seated. Metal seated valves shall have a beveled bottom gate. Metal seated valves shall provide shutoff capability to MSS SP-81 Knife Gate Valves.
 - e. Packing: The packing gland and the packing follower shall be stainless steel. The selected multiple ring packing set shall be for wet service. The fasteners shall be stainless steel.
 - f. Packing gland: Match valve body material.
 - g. Yoke: shall provide support for the valve actuator without bending or twisting.
- 11. Outside screw and yoke (OS&Y) with handwheel operator.
 - 12. Manually actuated valves 2 - 12" (50 - 300mm) shall have handwheel sized for a maximum rim pull of 60 pounds or fully enclosed, permanently lubricated, bevel gear actuators. Valves 14 - 36" (350 - 900mm) shall be supplied with bevel gear with handwheel actuators. Gear shall be Rotork model IB-RL-MD-RAW.

PART 3 EXECUTION

3.01 COMMISSIONING

- A. As specified in Section 01756 - Commissioning and this Section.
- B. Manufacturer services: For valves larger than 16-inches.
 - 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 40_05_65.24

CHECK VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Check valves.
- B. As specified in Section 40_05_51.01 - 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 NPS 24 Inch Standard.
- B. American Water Works Association (AWWA):
 - 1. C508 - Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.
- C. ASTM International (ASTM):
 - 1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. A313 - Standard Specification for Stainless Steel Spring Wire.
 - 3. A536 - Standard Specification for Ductile Iron Castings.
 - 4. B582 - Standard Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet, and Strip.
 - 5. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves.
- C. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Check valves: When not otherwise specified as indicated on the Drawings, provide check valves suitable for service as follows:
 - 1. In either horizontal or vertical position.
 - 2. Suitable for service working pressures up to 150 pounds per square inch gauge.

2.02 GENERAL SWING CHECK VALVES (CKV00)

- A. Valves 1/4-inch through 3 inches:
 - 1. Manufacturers: One of the following or equal:
 - a. Crane Valve Co., Number 36.
 - b. Lunkenheimer Co., Figure 554Y.
 - 2. Valve design:
 - a. Y-pattern body with integral seat.
 - b. Female threaded ends.
 - c. Renewable hinged disc.
 - d. Threaded cap for access to valve seat without disassembly of piping.
 - e. Integral seats suitable for regrinding.
 - 3. Materials:
 - a. Body: Bronze in accordance with ASTM B62-83600.
 - b. Disc Bronze ASTM B62 C92200.
 - 1) On valves less than 1-inch: Brass in accordance with ASTM B16.
 - c. Hinge: Bronze in accordance with ASTM B584 C 87600.
 - d. Lock nut and hinge pin plug: Brass in accordance with ASTM B16 HO2.
 - e. Hinge pin: Stainless steel in accordance with ASTM A276 .
 - f. Cap: Bronze in accordance with ASTM B61 C92200.
 - g. If used for steam service:
 - 1) Body and disc: S1 steam bronze in accordance with ASTM B61.

PART 3 EXECUTION

3.01 INSTALLATION

3.02 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and 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 40_05_00.09 - Piping Systems Testing.

END OF SECTION

SECTION 40_05_67.40

AIR RELEASE VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Air release valves,
- B. As specified in Section 40_05_51.01 - Common Work Results for Valves.

1.02 REFERENCES

- A. American Water Works Association (AWWA).

1.03 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 40_05_51.01 - Common Work Results for Valves.
- C. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.04 WARRANTY

- A. Provide warranty as specified in Section 01_78_36 - Warranties and Bond.

PART 2 PRODUCTS

2.01 PLASTIC BODY AIR RELEASE VALVES - CHEMICAL OR WATER SERVICE (ARV40)

- A. Manufacturers: One of the following or equal:
 - 1. A.R.I.
- B. Materials:
 - 1. Body: PVC
 - 2. Elastomers: EPDM
 - 3. Minimum pressure rating at 75 degrees Fahrenheit: 150 pounds per square inch gauge.
 - 4. Connection: 1/4 inch NPT minimum.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install as specified in Section 40_05_51.01 - Common Work Results for Valves and manufacturer's instructions.
- B. Install air release valves and air and vacuum valves with suitable discharge lines to nearest drainage system.

3.02 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and 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 40_05_51.01 - Common Work Results for Valves.

END OF SECTION

SECTION 40_61_00

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

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PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. General requirements applicable to all Process Control and Instrumentation Work.
 - 2. General requirements for process control and instrumentation submittals.
 - 3. As specified in this Section, some PLC programming and SCADA/HMI software configuration will be provided by the Owner, through the services of a consultant, hereinafter referred to as the Programmer.
- B. Interfaces to equipment, instruments, and other components:
 - 1. Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers, which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
 - 2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished:
 - a. Make all changes necessary to meet the manufacturer's wiring requirements.
 - 3. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation, control systems, and related services are provided. Include any items indicated on the Drawings or in Specifications from other disciplines in the scope of Work.
 - 4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation and control systems are completely accounted for. Include any items indicated on the Drawings or in Specifications from another discipline in the scope of Work:
 - a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
 - b. The Owner and Engineer are not responsible for providing detailed loop diagrams for Contractor furnished equipment.
- C. All instrumentation, and control equipment and systems for the entire project to comply with the requirements specified in the Instrumentation and Control Specifications, whether referenced in the individual Equipment Specifications or not:
 - 1. The requirements of the Instrumentation and Control Specifications apply to all Instrumentation and Control Work specified in other Specifications, including HVAC controls, packaged mechanical systems, LCPs, VCPs, etc.
 - 2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of the Instrumentation and Control Specifications.

3. Contractor shall be responsible for informing all subcontractor's and/or suppliers of all applicable requirements for Instrumentation and Control Devices for HVAC, including but not limited to programming, configuration, interface, and other requirements described in this Section.
 - a. Owner shall not be responsible for any additional costs due to the failure of Contractor to notify all subcontractors and/or suppliers for Instrumentation and Control Devices for HVAC requirements.
- D. Contract Documents:
 1. General:
 - a. The drawings and specifications are complementary and are to be used together in order to fully describe the Work.
 2. Specifications:
 - a. Supplementary Conditions of the Contract Documents govern the Work.
 - b. These requirements are in addition to all General Requirements.
 3. Contract drawings:
 - a. The Instrumentation and Control Drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the Instrumentation Work. Follow the drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best possible installation, use the entire drawing set for construction purposes.
 - b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only, exercise professional judgment in executing the Work to ensure the best possible installation:
 - 1) The equipment locations and dimensions indicated on the Drawings and elevations are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
 - 2) The Contractor has the freedom to select any of the named manufacturers as identified in the individual Specifications; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
 - c. Installation details:
 - 1) The Contract Drawings include installation details showing means and methods for installing instrumentation and control equipment. For cases where typical details are not provided or compatible with an installed location, develop installation details that are necessary for completing the Work, and submit these details for review by the Engineer.
 - d. Schematic diagrams:
 - 1) All controls are shown de-energized.

- 2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
- 3) Add relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
- 4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
- 5) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences indicated on the Drawings or in the Specifications. Combine all information and furnish a coordinated and fully functional control system.

1.02 REFERENCES

A. Code compliance:

1. As specified in Section 01_41_00 - Regulatory Requirements:
 - a. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
2. The following codes and standards are hereby incorporated into this Section:
 - a. American National Standards Institute (ANSI).
 - b. American Petroleum Institute (API):
 - 1) RP 550 - Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
 - 2) RP 551 - Process Measurement Instrumentation.
 - c. International Organization for Standardization (ISO):
 - 1) 9001 - Quality Management Systems - Requirements.
 - d. International Society of Automation (ISA):
 - 1) 5.1 - Instrumentation Symbols and Identification.
 - 2) 5.4 - Instrument Loop Diagrams.
 - 3) 20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
 - e. National Electrical Manufacturers Association (NEMA):
 - 1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
 - f. National Fire Protection Association (NFPA).
 - g. National Institute of Standards and Technology (NIST).
 - h. Underwriters Laboratories, Inc. (UL):
 - 1) 508 - Standard of Safety for Industrial Control Equipment.
 - 2) 508A - Standard of Safety for Industrial Control Panels.

B. Compliance with Laws and Regulations:

1.03 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations in accordance with:

1. Factory Mutual (FM).

2. International Electrotechnical Commission (IEC).
3. Institute of Electrical and Electronics Engineers (IEEE).
4. International Society of Automation (ISA).
5. International Organization for Standardization (ISO).
6. National Electrical Code (NEC).
7. National Electrical Manufacturers Association (NEMA).
8. InterNational Electrical Testing Association (NETA).
9. National Fire Protection Association (NFPA).
10. National Institute of Standards and Technology (NIST).
11. Underwriters Laboratories (UL).

B. Specific definitions:

1. Control circuit: Any circuit operating at 120 volts alternating current (VAC) or direct current (VDC) or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
2. Digital bus: A communication network, such as PROFIBUS, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions, and diagnostic information.
3. Modifications: Changing, extending, interfacing to, removing, or altering an existing circuit.
4. Panel: An instrument support system that may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems.
5. Power circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
6. Powered transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Section, the produced signal may be a 4 to 20 mA 24 VDC signal, a digital bus communications signal, or both.
7. RS-232: RS-232 is also known as TIA-232 or EIA-232, is a standard for serial communication transmission of data. When compared to RS-485 it has lower transmission speed, short maximum cable length, large voltage swing, large standard connectors and no multipoint capability. USB has displaced RS-232 from most of its peripheral interface roles.
8. RS-485: RS-485 is also known as TIA-485 or EIA-485, is a standard defining the electrical characteristics of drivers and receivers for use in serial communications system. Electrical signaling is balanced, and multipoint systems are supported, can be used with data rates up to 10 Mbit/s or at lower speeds distances up to 1,000 m (4,000 ft).
9. Signal circuit: Any circuit operating at less than 50 VAC or VDC, which conveys analog information or digital communications information.
10. 2-Wire transmitter (loop powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Section, 2-wire transmitter refers to a transmitter that provides a signal such as 4 to 20 mA 24 VDC regulation of a signal in a series circuit with an external 24 VDC driving potential:
 - a. Fieldbus communications signal or both.

11. USB: Universal Serial Bus is an industry standard that establishes specifications for cables, connectors, and protocols for connection, communication, and power supply interfacing between computer, peripherals, and other computers, it has largely replaced interfaces such as serial and parallel ports.

C. NEMA:

1. Type 1 enclosure in accordance with NEMA 250.
2. Type 2 enclosure in accordance with NEMA 250.
3. Type 3 enclosure in accordance with NEMA 250.
4. Type 3R enclosure in accordance with NEMA 250.
5. Type 3S enclosure in accordance with NEMA 250.
6. Type 3X enclosure in accordance with NEMA 250.
7. Type 3RX enclosure in accordance with NEMA 250.
8. Type 3SX enclosure in accordance with NEMA 250.
9. Type 4 enclosure in accordance with NEMA 250.
10. Type 4X enclosure in accordance with NEMA 250.
11. Type 5 enclosure in accordance with NEMA 250.
12. Type 6 enclosure in accordance with NEMA 250.
13. Type 6P enclosure in accordance with NEMA 250.
14. Type 7 enclosure in accordance with NEMA 250.
15. Type 8 enclosure in accordance with NEMA 250.
16. Type 12 enclosure in accordance with NEMA 250.
17. Type 12K enclosure in accordance with NEMA 250.
18. Type 13 enclosure in accordance with NEMA 250.

D. Acronym definitions:

1. ACB: Automatic current balance.
2. ATS: Automatic Transfer Switch.
3. CCS: The PCS central computer system (CCS) consisting of computers and software. The personal computer-based hardware and software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software and functions.
4. DPDT: Double-pole, double-throw.
5. ECP: Electronic circuit protector.
6. ES: Ethernet Switch.
7. FAT: Factory acceptance test also known as Source Test.
8. HART: Highway addressable remote transducer.
9. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
10. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to accept and implement the operators control instructions. Typically information is displayed in a graphical format.

11. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
12. IJB: Instrument junction boxes: A panel designed with cord sets to easily remove, replace, or relocate instrument signals.
13. I/O: Input/Output.
14. IP: Internet protocol or ingress protection.
15. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
16. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.
17. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.
18. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
19. NJB: Network junction box. An enclosure that contains multiple access points to various networks within the facility. Networks could be Ethernet, Ethernet/IP, Fieldbus, RIO, etc.
20. P&ID: Process and instrumentation diagram.
21. PC: Personal computer.
22. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Work specified in the Instrumentation and Control Specifications and depicted on the Instrumentation Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients, etc.
23. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
24. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.
25. PJB: Power junction box: An enclosure with terminal blocks that distribute power to multiple instruments.
26. PLC: Programmable logic controller.
27. PS: Power supply.
28. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.

29. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
30. SCADA: Supervisory control and data acquisition system: A general name for the computerized system that gathers and processes data from sensors and equipment located outside of the facility, such as wells, lift stations, metering stations, etc.
31. SELV: Safety extra-low voltage.
32. SFP: Small form-factor pluggable.
33. SPDT: Single-pole, double-throw.
34. SPST: Single-pole, single-throw.
35. UPS: Uninterruptible power supply.
36. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.
37. WAN: Wide area network: A control or communications network that extends beyond the physical boundaries of the facility.

1.04 SUBMITTALS

- A. Furnish submittals as specified in Section 01_33_00 - Submittal Procedures and this Section.
- B. General:
 1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
 2. Furnish the submittals required by each section in the Instrumentation Specifications.
 3. Adhere to the wiring numbering scheme specified in Section 26_05_05 - throughout the Project:
 - a. Uniquely number each wire.
 - b. Wire numbers must appear on all Equipment Drawings.
 4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.
 5. Submit the latest version of the manufacturers documentation.
 - a.
- C. Submittal preparation:
 1. During the period of preparation of submittals, the Contractor shall authorize direct, informal liaison between the ICSC and the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions may be authorized informally by the Engineer, which do not alter the scope of Work or cause increase or decrease in the Contract price or times. During this informal exchange, no oral statement by the Engineer shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant exception to, or variation from, these Contract Documents.

2. In these Contract Documents, some items of Work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ISA-5.1:
 - a. Employ the nomenclature and numbers designated in this Section and indicated on the Drawings exclusively throughout shop drawings, data sheets, and similar submittals.
 - b. Replace any other symbols, designations, and nomenclature unique to a manufacturer's, suppliers, or subcontractor's standard methods with those identified in this Section and indicated on the Drawings.
- D. Specific submittal requirements:
1. Shop drawings:
 - a. Required for materials and equipment listed in this and other sections.
 - b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
 - c. Shop drawings requirements:
 - 1) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
 - 2) Locations of conduit entrances and access plates.
 - 3) Component layout and identification.
 - 4) Schematic and wiring diagrams with wire numbers and terminal identification.
 - 5) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
 - 6) Weight.
 - 7) Finish.
 - 8) Nameplates:
 - a) As specified in Section 26_05_04 or as indicated on the Drawings.
 - 9) Temperature limitations, as applicable.
 - d. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
 - e. Adhere to wiring numbering scheme outlined in Section 26_05_05 - throughout the Project:
 - 1) Uniquely number each wire per the Specifications.
 - f. Wire numbers must appear on all equipment drawings.
 - g. Organize the shop drawing submittals for inclusion in the Operation and Maintenance Manuals:
 - 1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose-leaf, vinyl plastic, hard-cover binders suitable for bookshelf storage.
 - 2) Binder ring size: 2 inches.
 - h. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:
 - 1) The firm's registered business name.
 - 2) Firm's physical address, email address, and phone number.
 - 3) Owner's name.
 - 4) Project name and location.

- 5) Drawing name.
- 6) Revision level.
- 7) Personnel responsible for the content of the drawing.
- 8) Date.
- i. The work includes modifications to existing circuits:
 - 1) Clearly show all modifications to existing circuits.
 - 2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
2. Product data:
 - a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
 - b. Include:
 - 1) Catalog cuts.
 - 2) Bulletins.
 - 3) Brochures.
 - 4) Quality photocopies of applicable pages from these documents.
 - 5) Identify on the data sheets the Project name, applicable specification section, and paragraph.
 - 6) Identify model number and options for the actual equipment being furnished.
 - 7) Neatly cross out options that do not apply or equipment not intended to be supplied.
 - c. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
 - d. Adhere to wiring numbering scheme outlined in Section 26_05_05 throughout the Project:
 - 1) Uniquely number each wire per the Specifications.
 - e. Wire numbers must appear on all equipment drawings.
3. Detailed sequence of operation for all equipment or systems.
4. Operation and maintenance manuals:
 - a. As specified in Section 01_78_24 - Operation and Maintenance Manuals.
 - b. Operational Manual:
 - 1) Prepare and provide a simplified version of the standard manufacturer's HMI software and system operations manual that includes basic instructions in the application of the system as required for operators in day-to-day operations.
 - c. Control System Software Record Documents:
 - 1) Include complete documentation of all the software programs provided for the entire control and PCS system, including:
 - a) Listings of all application software on both hard copy and DVD, DVD-ROM, and CD-ROM.
 - b) Database, both hard copy and DVD, DVD-ROM, and CD-ROM.
 - c) Communication protocols.
 - d) All documentation necessary to maintain, troubleshoot, modify, or update the software system.
 - d. Organize the operation and maintenance manuals for each process in the following manner:
 - 1) Section A - Process and Instrumentation Diagrams.
 - 2) Section B - Control Descriptions.

- 3) Section C - Loop Drawings.
 - 4) Section D - Instrument Summary.
 - 5) Section E - Instrument Data Sheets and Brochures.
 - 6) Section F - Sizing Calculations.
 - 7) Section G - Instrumentation Installation Details.
 - 8) Section H - Test Results.
 - 9) Section I - Operational Manual.
 - 10) Section J - Spare Parts List.
 - 11) Section K - Control System Software.
5. Material and equipment schedules:
 - a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
 - 1) Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
 6. Itemized instrument summary:
 - a. Submit a hard copy of the instrument summary.
 - b. List all of the key attributes of each instrument including:
 - 1) Tag number.
 - 2) Manufacturer.
 - 3) Model number.
 - 4) Service.
 - 5) Area location.
 - 6) Calibrated range.
 - 7) Loop drawing number.
 - c. Associated LCP, VCP, PCM, or PLC.
 7. Instrument data sheets and cutsheets:
 - a. Furnish fully completed data sheets, both electronically in Microsoft Word or Excel and in hard copy, for each instrument and component according to ISA-20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. For instruments not included in ISA-20, submit data sheets using a similar format. The data sheets provided with the instrument specifications are preliminary and are not complete. They are provided to assist with the completion of final instrument data sheets. Additional data sheets may be required. Include the following information on the data sheet:
 - 1) Component functional description specified in this Section and indicated on the Drawings.
 - 2) Manufacturers model number or other product designation.
 - 3) Tag number specified in this Section and indicated on the Drawings.
 - 4) System or loop of which the component is a part.
 - 5) Location or assembly at which the component is to be installed.
 - 6) Input and output characteristics, including digital bus communication.
 - 7) Scale range with units and multiplier.
 - 8) Requirements for electric supply.
 - 9) Requirements for air supply.
 - 10) Power consumption.
 - 11) Response timing.
 - 12) Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.

- 13) Special requirements or features, such as specifications for ambient operating conditions.
- 14) Features and options that are furnished.
- b. Provide a technical brochure or bulletin ("cutsheet") for each instrument on the project. Submit with the corresponding data sheets:
 - 1) Where the same make and model of instrument is used in 2 or more applications on the project, and the process applications are nearly identical, and the materials, features and options are identical submit one brochure or bulletin for the set of identical instruments.
 - 2) Include a list of tag numbers for which it applies with each brochure or bulletin.
 - 3) Furnish technical product brochures that are complete enough to verify conformance with all Contract Document requirements, and to reflect only those features supplied with the device.
 - 4) Cross out models, features, options, or accessories that are not being provided.
 - 5) Clearly mark and identify special options and features.
- c. Organization: Index the data sheets and brochures in the submittal by systems or loops.
8. Control panel hardware submittal:
 - a. Submit the following in 1 submittal package.
 - b. Complete and detailed bills of materials:
 - 1) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
 - 2) Include all items within an enclosure.
 - c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.
 - d. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium-voltage power cables.
 - e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
 - f. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
 - 1) The manufacturer's model number or other identifying product designation.
 - 2) Tag and loop number.
 - 3) System to which it belongs.
 - 4) Site to which it applies.
 - 5) Input and output characteristics.
 - 6) Requirements for electric power.
 - 7) Device ambient operating requirements.
 - 8) Materials of construction.
9. Schedule of values:
 - a. In addition to completing all items referred to in the schedule of values, Section 01_29_73 - Schedule of Values, submit per unit instrument and labor costs used in developing the final bid for the PCS system, for the express purpose of pricing and cost justification for any proposed change orders. It is the responsibility of the ICSC subcontractor to prove to the

Engineer's satisfaction that said per unit costs were used in the development of the final Bid amount.

10. Installation recommendations:
 - a. Submit the manufacturer's printed recommendations for installation of instrumentation equipment.
11. Training submittals:
 - a. Develop and submit for review a general training plan for approval by Owner within 14 calendar days from Notice to Proceed. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
 - b. The Engineer will review the general training plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the Engineer, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system, provide more qualified instructors.
 - c. The general training plan and schedule shall be updated by the Contractor at the beginning of each Phase and approved by the Owner a minimum of 30 days prior to commencement of training.
 - d. Training course plan submittals:
 - 1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson as specified in Section 01_75_17 - Commissioning.
 - 2) Describe any student pre-requisites for the course or training activity.
 - 3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
 - 4) Submit training materials.
 - e. Incorporate all submittal review comments into the course.
 - f. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.
12. Project Record documents:
 - a. Furnish as specified in Section 01_77_00 - Closeout Procedures.
 - b. Record Drawing requirements:
 - 1) Provide Project Record Drawing of all Instrumentation Drawings.
 - 2) Update Record Drawings weekly.
 - 3) Record Drawings must be fully updated as a condition of the monthly progress payments.
 - 4) Clearly and neatly show all changes including the following:
 - a) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
13. Loop Drawings:
 - a. Submit loop drawings for every analog, discrete, and fieldbus signal and control circuit:
 - 1) Provide a loop drawing submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop on this Project.

- 2) This requirement applies to all signal and control circuits associated with equipment on this Project including vendor supplied equipment packages and control panels.
- 3) Provide loop drawings in the format indicated in the contract drawings. Provide all tagging in accordance with the Owner's standard.
- b. Show every instrument and I/O point on at least one loop diagram.
- c. Provide a complete index in the front of each bound volume:
 - 1) Index the loop drawings by systems or process areas.
- d. Provide drawings showing definitive diagrams for every instrumentation loop system:
 - 1) Show and identify each component of each loop or system using requirements and symbols from ISA-5.4.
 - 2) Furnish a separate drawing sheet for each system or loop diagram.
- e. In addition to the ISA-5.4 requirements, show the following details:
 - 1) Functional name of each loop.
 - 2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
 - 3) Show all terminal numbers, regardless of the entity providing the equipment.
 - 4) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.
 - 5) Designation of and, if appropriate, terminal assignments associated with, every manhole, pull-box, junction box, conduit, and panel through which the loop circuits pass.
 - 6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCS terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
 - 7) If a circuit is continued on another drawing, show the name and number of the continuation drawing on the loop drawing. Provide complete references to all continuation drawings whether vendor control panels, other loop drawings, existing drawings provided by the Owner, or other drawings.
- f. In addition to the above requirements, provide loop diagrams in accordance with the example loop diagram as indicated on the Drawings.
14. Instrument Installation Drawings:
 - a. Submit, instrument installation, mounting, and anchoring details for all components and assemblies, including access requirements and conduit connection or entry details.
 - b. Furnish for each instrument a dedicated 8 1/2-inch by 11-inch installation detail that pertains to the specific instrument by tag number.
 - c. For each detail, provide certification and the hard copies, by the instrument manufacturer, that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.
 - d. For each detail, provide, as a minimum, the following contents:
 - 1) Necessary sections and elevation views required to define instrument location by referencing tank, building or equipment names and numbers, and geographical qualities such as north, south, east, west, basement, first floor, etc.

- 2) Ambient temperature and humidity where the instrument is to be installed.
 - 3) Corrosive qualities of the environment where the instrument is to be installed.
 - 4) Hazardous rating of the environment where the instrument is to be installed.
 - 5) Process line pipe or tank size, service and material.
 - 6) Process tap elevation and location.
 - 7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
 - 8) Routing of tubing and identification of supports.
 - 9) Mounting brackets, stands, anchoring devices, and sun shades.
 - 10) Conduit entry size, number, location, and delineation between power and signal.
 - 11) NEMA ratings of enclosures and all components.
 - 12) Clearances required for instrument servicing.
 - 13) List itemizing all manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.
15. Control Panel Drawings:
- a. Layout Drawings:
 - 1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
 - 2) As a minimum, include the following information:
 - a) To scale front, side, and plan views.
 - b) Dimensions.
 - c) Interior and exterior arrangements.
 - d) Mounting information, including conduit entrance location.
 - e) Finish data.
 - f) Tag number and functional name of items mounted in and on each panel, console, and cabinet.
 - g) Nameplate legend including text, letter size, materials, and colors.
 - b. Wiring and piping diagrams:
 - 1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
 - 2) Include the following information:
 - a) Name of panel.
 - b) Wiring and piping sizes and types.
 - c) Terminal strip numbers.
 - d) Wire tags and labels.
 - e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
 - f) Electrical control schematics in accordance with ANSI standards.
 - c. Installation drawings:
 - 1) Provide site-specific installation drawings for all control equipment panels, including dimensions.
 - 2) Provide scaled drawings and show the position of the equipment at its intended installation location.

- 3) Show the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
 - 4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.
16. Schematic Diagrams:
 - a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
 - b. Include device and field connection terminal numbers on all schematic diagrams.
 - c. Incorporate equipment manufacturer's shop drawing information into the schematic diagrams in order to document the entire control system.
17. Control System Diagram:
 - a. Submit a complete set of control system diagrams including the following information:
 - 1) All PLCs, workstations, printers, communication devices, and communication links:
 - a) Show all PLCs with their current I/O allocation, and future I/O allocation, current plus spares provided, and maximum potential I/O based on available slots.
 - 2) All cables required for communication requirements.
 - 3) Show each component fully annotated with conduit size and number associated with the power source.
18. Process Control Software Submittal:
 - a. In accordance with Product Data and Shop Drawing general requirements.
 - b. Submit a complete description of the standard application software programs, operating system and utility programs, including modifications and explanation of how the specific functional requirements are met:
 - 1) Provide a cross-reference between the Specification requirements and the software submittal, in order to provide the Engineer the ability to identify how each specified requirement or function is met.
 - c. A complete listing of the PCS system point I/O database:
 - 1) Include for each data point, relevant parameters such as range, contact orientation, limits, incremental limits, I/O card byte, I/O hardware address, and PLC assignment.
 - 2) Organize on a site-by-site basis, separate by point type.
 - 3) In addition to the active I/O points, list the implemented spare I/O points and the available I/O points remaining on each card, as well as other defined future points specified or shown.
 - 4) Upon completion of the Work, update all I/O lists to indicate the final as-built configuration of the systems:
 - a) Organize as-built I/O list on a site-by-site basis, separated by equipment and point type.
 - d. Detailed descriptions of procedures used to implement and modify control strategies and database construction.
 - e. Preliminary overview, screens, station graphic displays, and preliminary reports.

19. Instrumentation and Control System Contractor Statement of Qualifications:
 - a. Submit statement of qualifications of the proposed ICSC in accordance with subsequent requirements of this Section.
20. Control Descriptions:
 - a. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls as shown on the P&IDs:
 - 1) Include all functions depicted or described in the Contract Documents.
 - 2) Include within the Control Description content:
 - a) All specific requirements.
 - b) All common requirements that pertain in general to all loops.
 - c) Listing all ranges, setpoints, timers, values, counter values, etc.
21. Test Procedure Submittals:
 - a. Submit the proposed procedures to be followed during tests of the PCS and its components in 2 parts:
 - 1) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
 - 2) Detailed Submittal: After successful review of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. Include a statement of test objectives with the test procedures.
22. Test reports:
 - a. As specified in Section 01_33_00 - Submittal Procedures.
23. Meetings as specified in this Section:
 - a. Agenda.
 - b. Meeting minutes.

1.05 QUALITY ASSURANCE

- A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.
- B. ICSC qualifications:
 1. General information on the proposing company:
 - a. Document that the ICSC Company has been actively involved in the instrumentation, PLC-based control systems business for a minimum of five years and has adequate facilities, organization structure, manpower, and technical and managerial expertise to properly perform the Work as specified in these Specifications.
 2. Similar project experience of the company:
 - a. Provide a list of at least 3 successfully completed projects for a water and/or wastewater system of similar scope and complexity in which the proposing firm used components the same as those intended for use on this Project. The proposing firm must have performed, for each listed project, system engineering, system fabrication and installation, documentation (including schematic, wiring and panel assembly drawings), software configuration and documentation, field testing, calibration and process start-up, operator instruction, and maintenance training. In addition, provide the following information for each project:
 - 1) Name of plant or system owner, contact name, and current telephone number. Design engineer's name, address, and telephone number.

- Failure to provide current contact information may result in the listed project being disqualified for use in meeting the minimum requirements for prequalification.
- 2) Manufacturer and model number(s) of the PLC based control system and the computer-based SCADA system used for both hardware and software.
 - 3) Brief description of the system.
 - 4) Approximate number of input and output signals: analog, digital, and fieldbus.
 - 5) Brief application software description.
 - 6) Contracted cost of the system, separate by base amount and any change orders for the completed projects.
 - 7) Duration of the project and date of completion.
3. Information on the proposed Project team members:
 - a. Provide the name and resume of the individual persons who will be responsible for each of the following:
 - 1) Office engineering and management of this Project.
 - 2) Lead for software configuration/programming.
 - 3) Individual who will be responsible for the hardware and hardware interface design.
 - 4) Individual who will be responsible for field testing, calibration, and process start-up.
 - 5) Individual who will be responsible for operator training.
 - b. All of these individuals must be permanent employees of the proposing firm.
- C. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.
- D. The ICSC must have their own operating UL listed panel fabrication facility. All panels must be fabricated at this facility and meet all UL 508/508A requirements.
- E. ICSC:
1. Contractor, through the use of a qualified ICSC, is responsible for the implementation of the PCIS and the integration of the system with other required instrumentation, control devices, and software.
 2. The ICSC assumes full responsibility, through the Contractor, to perform all work to select, furnish, install, program, test, calibrate, and place into operation all instrumentation, controls, telemetry equipment, control panels, and control system including application software, for a complete, integrated and functional PCIS system.
 3. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these Specifications that the ICSC be responsible for the integration of the PCIS devices provided under the Contract Documents with the objective of providing a completely integrated control system.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 01_60_00 - Product Requirements.

B. Shipping precautions:

1. After completion of shop assembly, successful Source Test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
2. Place dehumidifiers when required, inside the polyethylene coverings.
3. Skid-mount the equipment for final transport.
4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

C. Special instructions:

1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.
2. Contractor shall ship the PCS equipment listed below to Programmer's office within 175 days after Notice to Proceed is issued to Contractor:
 - a. PLCs to be programmed by Programmer, including all chassis, power supplies, CPUs, IO modules, cables, programming software, and related equipment.
 - b. All network communications equipment and cables less than 10 feet in length.
 - c. Any personal computers and related software.
3. The Programmer shall be allowed to keep the above equipment for a minimum of 180 calendar days and additionally until 30 days prior to the start of the factory test for the applicable PLC control panels. The Contractor shall allow sufficient time in the Project Schedule for this 180 day requirement. The Contractor is responsible to obtain necessary submittal reviews, order equipment, and allow sufficient delivery time to comply with this requirement. No schedule extension shall be allowed due to failure of the Contractor to comply with these requirements.
4. The Contractor shall also supply, for the use of the Programmer, samples of any devices or equipment that will communicate to the Programmer-programmed PLCs using Modbus, Modbus plus, Fieldbus, or any other digital network. These samples must be shipped to the Programmer's facility and remain there for a minimum of 90 days prior to the PLC panel factory tests.
5. Contractor shall be responsible for shipping the above equipment from the Programmer's facility. At the designated time for shipment of the above equipment to the factory test site or the field (whichever applies), the Contractor shall send personnel to the Programmer's office to package and ship the equipment to the factory test site. The Contractor shall have sole responsibility to package and ship the equipment, including packing materials and shipping charges. Prior to packaging and shipping, the Contractor shall examine and test all equipment, as needed, and shall certify, in writing, that the equipment appears to be in proper working order, and shall deliver the certification to the Programmer, who will forward copies to the Owner and Engineer.

D. Tagging:

1. Tag each component and/or instrument to identify its location, instrument tag number, and function in the system.

2. Firmly attach a permanent tag indelibly machine marked with the instrument tag number, as given in the tabulation, on each piece of equipment constituting the PCS.
 3. Tag instruments immediately upon receipt in the field.
 4. Prominently display identification on the outside of the package.
 5. Utilize the Tag and Loop Number identifications shown on the P&IDs.
- E. Delivery and inspection:
1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.

1.07 PROJECT OR SITE CONDITIONS

- A. Site conditions:
1. Provide a PCS, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
 2. Seismic classification:
 - a. Provide all equipment and construction techniques suitable for the seismic requirements for the site, as specified in Section 01_81_50 - Design Criteria.
 3. Wind:
 - a. Provide all equipment and construction techniques suitable for the site wind loading criteria, as specified in Section 01_81_50 - Design Criteria.
 4. Altitude, temperature and humidity:
 - a. As specified in Section 01_81_50 - Design Criteria.
 - b. Provide all equipment and instrumentation fully rated for continuous operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
 - c. Provide additional temperature conditioning equipment to maintain all equipment and instrumentation in non-conditioned spaces or outdoors subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment manufacturer's guidelines:
 - 1) Provide all power wiring for these devices (e.g., heaters, fans, etc.), whether or not indicated on the Drawings.
 5. Area classifications:
 - a. Furnish enclosures that match the area classifications as specified in Section 26_05_02 and 26 05 04

1.08 SEQUENCING

- A. General:
1. As specified in Section 01_31_19 - Project Meetings and Section 01_75_17 - Commissioning.
 2. Testing requirements are specified in Section 01_75_17 - Commissioning and Section 40_80_01 - Commissioning for Instrumentation and Controls.
 3. General scheduling requirements are specified in Section 01_32_21 - Schedules and Reports.

4. Work restrictions and other scheduling requirements are specified in Section 01_14_00 - Work Restrictions.
 5. Commissioning requirements as specified in Section 01_75_17 - Commissioning.
- B. For every meeting specified in this Section:
1. Agenda:
 - a. Submit 7 days in advance of the meeting date.
 2. Meeting minutes:
 - a. Provide draft minutes for comment by all attendees within 7 days of completion of the meeting.
 - b. Incorporate comments from attendees and submit final meeting minutes within 7 days of receipt of comments transmitted by the construction manager.
- C. Pre-submittal conferences:
1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.
 2. The Contractor, instrumentation and control subcontractor, electrical subcontractor, and all manufacturers furnishing major pieces of equipment must attend, including but not limited to:
 - a. Vendor control panels.
 - b. Chemical feed systems.
 - c. Motor control centers.
 - d. Switchgear.
 - e. Variable frequency drives.
 - f. Lighting.
 - g. Engine generators.
- D. System configuration meetings:
1. Review the system configuration, the HMI system database, control schemes, displays, report formats, etc. with the Engineer and Owner on at least 3 occasions during development:
 - a. Preliminary meeting: Before configuration work is begun. The ICSC must bring to this meeting example of displays, display symbols, reports, etc. to show the capabilities of the system software.
 - b. Intermediate review meeting: Held after the initial database is entered and typical screens and reports have been entered.
 - c. Pre-submittal review meeting: Submit an informal hardcopy of developed HMI screens for review by the Engineer to determine that requirements are being sufficiently met.
 - d. Final review meeting: Held after initial completion of all configuration work. This final meeting may not be held in conjunction with the Source Test. Make final format revisions after this review.
 2. Additional requirements as specified in Sections 40_61_15 - Control Strategies, , 40_64_01 - Control Systems: Programmable Logic Controllers,

E. Control logic meetings

1. Review the PLC programming with the Programmer, Engineer, and Owner on at least 3 occasions during development. Individuals responsible for programming PLCs and other programmable devices supplied by Contractor shall attend this meeting by telephone conference call.
 - a. Preliminary meeting: Meet before configuration work is begun on any PLCs programmed by the Contractor (including those provided through subcontractors and suppliers).
 - 1) Contractor shall provide a list of each PLC and other programmable devices that will interface to the rest of the control system, including make, model, and a description of the interface; provide contact information for each individual responsible for programming each said PLC and device; and provide a listing of the submittals that will contain HMI/LOI interface information with a schedule for when each submittal will be provided.
 - b. Intermediate review meeting: Held after approximately one-half of the interface submittals identified in the Pre-submittal Conferences paragraph above have been submitted.
 - 1) Individuals responsible for programming PLCs and other programmable devices supplied by Contractor shall attend this meeting.
 - 2) Meet to discuss all control system interface submittals and their requirements.
 - c. Final review meeting: Held after all HMI/LOI interface submittals have been submitted.
 - 1) Meet to discuss HMI/LOI interface submittals and requirements.
2. Vendor Equipment Meetings: Facilitate a meeting with each equipment supplier (including HVAC) who is providing equipment with a PLC and/or LOI. Meeting discussion point will include the following at a minimum:
 - a. Tag naming conventions.
 - b. PLC to PLC global data mapping.
 - c. All PLCs to HMI tags mapping.
 - d. LOI screen colors and navigation.
 - e. Interlock and permissive definitions.
 - f. Communication methods.
 - g. Standard code blocks for common control functionality.
 - h. Alarms: Clearing, formats, colors, and status.
3. Additional requirements as specified in Sections 40_61_15 - Control Strategies, 40_64_01 - Control Systems: Programmable Logic Controllers,

F. Source testing:

1. Before the delivery and installation of the PCS system to the job site, but after the procurement, assembly, and configuration of all components, perform the Source Test.
2. Before the delivery and installation of control panels, PLCs, control system equipment, and other PCS components at the job site, but after the procurement and assembly of components, perform Source Test.
3. Schedule the Source Test after receiving approval of the Source Test procedures submittal.

4. Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
 5. Notify the Engineer of scheduled tests a minimum of 15 days before the date of the test.
- G. General Field Start-Up and testing procedures:
1. As specified in Section 01_75_17 - Commissioning.
- H. Installation testing:
1. As specified in Section 01_75_17 - Commissioning.
 2. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
 3. Acceptance of the PCIS Installation testing must be provided in writing by the Owner before the performance testing may begin.
- I. Training:
1. As specified in Section 01_75_17 - Commissioning.
- J. Functional testing:
1. Representatives from each of the following groups shall be in attendance during the functional Testing: Programmer, Vendor System Supplier of vendor package system that has PLC. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
 2. Loop validation test.
 3. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.
 - a. Notify the Owner of scheduled tests a minimum of 21 days before the estimated completion date of installation and wiring of the PCIS.
 - b. Complete loop validation testing a minimum of 5 days before the pre-commissioning phase of the project.
 - c. Loop validation certifications:
 - 1) After the field device loop tests have been successfully completed as specified in Section 40_80_01 - Commissioning for Instrumentation and Controls for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc., submit a certified copy of all test forms signed by the Contractor, Vendor, and the Owner's representative with test data entered, together with a clear and unequivocal statement that all instrumentation, including all control and signal wiring, has been successfully calibrated, inspected, and tested.
 - a) Acceptance of the PCIS Installation Testing must be provided in writing by the Engineer before the Process Operational Period may begin.
 - d. The Programmer will assist with Functional Testing for PLCs programmed by the Programmer, as specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

- e. The Programmer shall not be required to be on site, nor shall the Programmer be required to supply application software, until the loop validation tests are complete for a PLC and all prerequisites for the Process Operational Period are completed.
- K. Provide all special tools and spare parts, as specified in the Maintenance paragraph of this Section, before Process Operational Period commences, suitably wrapped, and identified.
- L. Process Operational Period:
 - 1. Upon completion of the Process Operational Period, conduct an Instrumentation and Controls Process Performance Test as a condition for Project final completion.

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

- A. Provide additional warranty as specified in the individual Instrumentation and Control Specifications that extends beyond the Correction Period, as specified in Documents 00_78_36 - Warranty and Bonds

1.11 SYSTEM PROCESS START-UP

- A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
 - 1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE

- A. Before Substantial Completion, perform all maintenance activities required by the Contract Documents including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.
- B. Furnish all spare parts as required by the Contract Documents.
- C. Spare parts:
 - 1. Furnish the spare parts selected by the Engineer from the priced list of spare parts in the hardware submittal.
 - 2. Furnish a price list of all special tools required to calibrate and maintain all of the instrumentation provided under the Contract Documents. Furnish the special tools selected by the Engineer from the priced list.

- D. Provide additional spare parts specified in other sections of the Instrumentation and Control Specifications.
- E. Submit all special tools and spare parts, suitably wrapped and identified, before Process Operational Period commences.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide similar items from a single manufacturer throughout the PCIS portion of the Project.
- B. Allowable manufacturers are specified in individual instrument and equipment specifications.

2.02 SYSTEM DESCRIPTION

- A. General requirements:
 - 1. The Work includes everything necessary for and incidental to executing and completing the instrumentation and control system work indicated on the Drawings and specified in the Specifications and reasonably inferable there from including but not limited to:
 - a. Preparing hardware submittals for field instrumentation.
 - b. Design, develop, and draft loop drawings, control panel designs, and all other drawing submittals specified in the Instrumentation and Control Specifications.
 - c. Prepare the test plan, the training plan, and the spare parts submittals.
 - d. Procure all hardware.
 - e. Provide all PCS system hardware.
 - f. Provide all PCS system software.
 - g. Fabricate panels.
 - h. Perform factory tests on panels.
 - i. Perform bench calibration and verify calibration after installation.
 - j. Oversee and certify installation of the PCS system.
 - k. Oversee, document, and certify loop testing.
 - l. Oversee, document, and certify system.
 - m. Installation Testing.
 - n. Oversee and document Functional Testing.
 - o. Conduct the Process Operational Period and the Instrumentation and Controls Process Performance Testing.
 - p. Prepare operation and maintenance manuals.
 - q. Conduct training classes.
 - r. Integrate the PCS with instrumentation and control devices provided under other sections.
 - s. Provide Record Drawings and Loop Drawings associated with Instruments and equipment:
 - 1) As specified in the Contract Documents.
 - 2) For Owner furnished items.
 - 3) For interfaces with existing equipment.

- t. Resolve signal, power, or functional incompatibilities between the PCS and interfacing devices.
 - u. Perform all required corrective and preventative maintenance.
- 2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of all equipment furnished by others, as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
- 3. Provide the complete operating PCS to perform the specified monitoring, communications, alarm, control, display, and reporting functions in accordance with the PCS requirements.
- 4. The Owner, through the services of the Programmer, will provide the configuration and programming for parts of the PLC and PC based control system, as described below.
 - a. The following PLCs will be programmed by the Programmer:
 - 1) PLC-DIW-1, DIW-2.
 - b. The CCS consisting of personal computers and software that will be configured by the Programmer.
 - c. All other PLCs and other programmable devices shall be programmed by the Contractor, either directly or through the services of other entities such as subcontractors, equipment suppliers, and packaged equipment suppliers (vendors).
 - d. The Programmer will assist with the testing of the software provided by the Programmer, as specified in this Section and in Section 40_80_01 - Commissioning for Instrumentation and Controls.
- 5. Coordinate all aspects of the Work between Contractor and all subcontractors before bidding to ensure that all costs associated with a complete installation are included. Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the ICSC, the other subcontractors, or suppliers.
- 6. Furnish detailed, complete, and thorough operations and maintenance documentation, including but not limited to operations manuals, maintenance manuals, as-built wiring drawings, training manuals, as-built software documentation, and all other documentation required to operate, modify, and maintain all parts of the PCS.
- 7. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment.
 - a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before performing any Work.
 - b. Provide and document interface with, modifications to, upgrade, or replacement of existing circuits, power systems, controls, and equipment.
- 8. Revise in a manner as directed by the Engineer all I/O and addressing that the Engineer determines to be unacceptable as a result of a lack of Contractor coordination between Contract Documents and all suppliers.
- 9. Defective Work:

- B. Operating facility:
1. As specified in Section 01_14_00 - Work Restrictions.
 2. Portions of this existing facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
 - a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction to meet the requirements of the Owner.
 - b. As weather and facility demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
 - c. Where portions of the Work are in existing facilities and require interface to existing circuits, power systems, controls and equipment, perform comprehensive and detailed field investigations of existing conditions. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
 - d. Temporary control systems:
 - 1) Provide temporary controls at the following locations in order to keep the facility fully operational during Work on the electrical and control systems:
 3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
 4. Where shown or specified, replace existing field instruments with new.
 5. Contractor is responsible for the integrity and measurement accuracy of all loops.
 6. Any defect found in existing equipment is the responsibility of the Owner. Contractor is not responsible for defects on existing Owner components.
 7. The standards of documentation, instrument tagging, cable and conductor termination, terminal identification and labeling that apply to the new installation apply equally to the existing installation.

2.03 EXISTING PRODUCTS (NOT USED)

2.04 MATERIALS

- A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the Specifications.
- B. Provide materials complying with the applicable industrial standard as specified in the Contract Documents.

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

- A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise specified to match existing equipment.
- B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of within 0.5 percent of full scale and a minimum repeatability of within 0.25 percent of full scale.
- C. Signal transmission:
 - 1. Analog signals:
 - a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
 - b. Furnish electrical analog signals outside control panels that are 4-to-20 milliamperes 24 VDC, except as indicated.
 - c. Electrically or optically isolate all analog signals from other signals.
 - d. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
 - e. Maintain the total 4-to-20 milliamperes loop impedance to 10 percent below the published value at the loop operating voltage.
 - f. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
 - 2. Pneumatic signals:
 - a. All pneumatic signals: 3-to-15 pounds per square inch gauge.
 - 3. Discrete input signals:
 - a. As indicated in the controller hardware specification.
 - 4. Discrete output signals:
 - a. Dry contacts or TRIAC outputs (with express written approval by the Engineer) as needed to coordinate with the field device.
 - b. Provide external terminal block mounted fuse with blown fuse indication for all discrete outputs.
 - c. Provide interposing relays for all discrete outputs for voltage and/or current compatibilities.
 - d. Provide interposing relays as required for functionality of the control circuit.
 - 5. Signal performance and design criteria:
 - a. Stability:
 - 1) After Controls have taken corrective action, oscillation of the final control element shall not exceed 2 cycles per minute or a magnitude of motion of 0.5 percent of full travel.
 - b. Response:
 - 1) Any change in setpoint or controlled variable shall produce a corrective change in position of the final control element and stabilized within 30 seconds.
 - c. Agreement:
 - 1) Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.

- d. Repeatability:
 - 1) For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position the final element.
 - e. Sensitivity:
 - 1) Controls shall respond to a setpoint deviations and measured variable deviations within 1.0 percent of full scale.
 - f. Performance:
 - 1) All instruments and control devices shall perform in accordance with the manufacturers' specifications.
- D. Discrete circuit configuration:
- 1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
 - 2. Alarm contacts: Fail to the alarm condition.
 - 3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.
- E. Grounding:
- 1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
 - 2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable.
 - 3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
 - 4. Terminate the signal cable shield on a dedicated grounding terminal block.
 - 5. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.
- F. Instrument air:
- 1. Where indicated on the Drawings, provide dry, filtered control air at 30 pounds per square inch gauge nominal pressure piped to all field instruments and instrument panels requiring air:
 - a. Provide each field instrument with an integral, non-adjustable filter/regulator assembly to provide regulated air.
 - b. Provide each instrument panel requiring air with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments.
 - c. Filter all air to 5-micron maximum particle size.
 - d. Provide low pressure switch to alarm on insufficient air supply.

2.08 ACCESSORIES

- A. Provide flow conditioning devices or other required accessories if necessary to meet the accuracy requirements in the Contract Documents.

- B. Nameplates:
1. Provide a nameplate for each controller, instrument transducer, instrument power supply, solenoid, or any other control device located either in the field or within panels.
 2. All nameplates shall be of identical style, color, and material throughout the facility.
 3. Device nameplates shall include:
 - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
 - 1) Device tag and loop number ID (e.g., FIT-60.011).
 - 2) PLC ID (e.g., PLC-11).
 - 3) Power information (e.g., PCM-11, 120 VAC).
 - b. White lettering on a black background, laminated plastic.
 4. All instruments shall be equipped with Type 316 stainless steel nameplate with the instrument tag stamped in 3/8-inch letters and connected to the instrument using Type 316 stainless steel wire.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL

- A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the Specifications.
- B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the Owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
1. Equipment includes the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.
- C. Source Test is specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The ICSC is encouraged to visit the site and examine the premises completely before bidding. It is the ICSC's responsibility to be fully familiar with the existing conditions and local requirements and regulations.
- B. Review the existing Site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

- C. Provide a complete instrumentation and control system:
 - 1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, and process control and instrumentation system.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Equipment locations indicated on the Drawings may change due to variations in equipment size or minor changes made by others during construction:
 - 1. Verify all dimensions as indicated on the Drawings:
 - a. Actual field conditions govern all final installed locations, distances, and levels.
 - 2. Review all information indicated on the Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical, instrumentation, and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
 - 3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
- B. Perform all related Electrical Work in accordance with the applicable sections of the Electrical Specifications.
- C. The PCIS configurations are diagrammatic:
 - 1. The locations of equipment are approximate unless dimensioned.
 - 2. Where Project conditions require, make reasonable changes in locations and arrangements.
- D. Field instruments installation:
 - 1. Install field instruments as specified in the Contract Documents, API RP 550 and RP 551, and the manufacturer's instructions.
 - 2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
 - a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
 - b. Provide sun shields for all field electronic instruments located outdoors.
 - 3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
 - a. Type of flexible conduit required for the area classification:
 - 1) Area classification as specified in Section 26_05_02
 - b. Maximum length of 18 inches.
 - 4. Connect field instruments with cable as specified in the Electrical Specifications, except when the manufacturer requires the use of special cable, or otherwise specified in this Section:
 - a. Special cable applications shall be in accordance with the NEC.
 - 5. Verify the correctness of each installation:
 - a. Polarity of electric power and signal connections.
 - 6. Ensure all process connections are free of leaks.

- E. Process sensing lines and air tubing:
 - 1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
 - 2. Provide supports for rigid tubing at intervals of not more than 3 feet.
 - 3. Slope horizontal runs of instrument tubing at a minimum of 1/16-inch per foot to allow for draining of any condensate.
 - 4. Bends:
 - a. Make bends for parallel lines symmetrical.
 - b. Make bends without deforming or thinning the walls of the tubing.
 - 5. Square-cut and clean all ends of tubing before being inserted in the fittings.
 - 6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.
 - 7. Use stainless steel tubing for all piping hard piped from the air header, unless otherwise indicated on the Drawings or not compatible with the fluids or atmosphere in the area:
 - a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.
- F. Equipment tie-downs:
 - 1. Anchor all instruments, control panels, and equipment by methods that comply with wind bracing requirements, which apply to the Site.
 - 2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., shall be permanently mounted and tied down to structures.
- G. Instrument tagging:
 - 1. Provide all field-mounted instruments with nameplates:
 - a. Nameplates engraved with the instrument's full tag number as indicated on the Drawings:
 - 1) Affix tags with stainless steel wire fasteners.
 - 2. Provide all back of panel instruments with nameplates:
 - a. Engraved with the instrument's full tag number as indicated on the Drawings:
 - 3. Provide all front of panel instruments with a nameplate:
 - a. Engraving to include the following:
 - 1) Instrument's full tag number.
 - 2) Service description.
 - b. Nameplates:
 - 1) Secure nameplates to the panel with stainless steel screws.
 - 2) Use an accepted adhesive if screws would violate the NEMA or other ratings of the enclosure.
- H. Cable and conductor termination:
 - 1. Terminate all cables and conductors on terminal blocks.
 - 2. Terminal block enclosures:
 - a. Suitable for the area classification as specified in Section 26_05_02
- I. Surge protection:
 - 1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments and the panel.

2. Individually fuse each 4 to 20 milliamperes direct current loop with a 1/2-ampere fuse between power supplies and receiver surge protectors.
 3. Provide voltage surge protection for 4 wire transmitters and analyzers:
 - a. Protect both power source and signal loop.
- J. Scope and responsibilities:
1. Refer to the following table for procurement and installation scope and responsibilities for the owner, design engineer, contractor.
 2. All primary responsibilities of ICSC, Programmer, and vendor system supplier will be led by the Contractor and/or Owner.

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
1.00	I&C Design Update			
1.01	Update I&C design to incorporate any changes, if changes approved by Owner during the submittal processes, for equipment and/or package systems.	Assist		Lead
2.00	HMI Application Programming			
2.01	HMI software application programming.	Lead		
2.02	Develop PLC/DCS interfaces to Vendor package systems (Vendor package system programmed by Vendor).	Assist	Lead	Assist
2.03	Digital field network interface and network configuration (ownership including calibration and setup).		Lead	
2.04	HMI graphical user interface.	Lead		Assist
3.01	Configuration of auxiliary systems necessary to provide required functionality and connectivity for monitoring and control of auxiliary systems: HVAC, power monitors, lighting, and fire protection.		Lead	
4.00	Integration			
4.01	Instrumentation specifications and procurement.		Lead	

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
4.02	Vendor-supplied package and auxiliary system coordination with plant PLC/DCS (communications, submittals, software development).		Lead	
4.03	Vendor package systems and auxiliary system interface demonstration at FAT, where required.		Lead	Assist
4.04	Control system equipment, Vendor package system, and auxiliary system interface submittal review and preparation for formal Owner review.		Lead	Assist
4.05	I&C design update to reflect approved Vendor submittals (if required).	Support	Assist	Lead
5.00	Equipment and Panels			
5.01	PLC/DCS Process Control System			
5.02	PLC/DCS control panels and associated panel equipment procurement.		Lead	
5.03	PLC/DCS control panels and associated panel equipment fabrication.		Lead	
5.04	PLC/DCS control panels factory testing.	Witness	Lead	Witness
5.05	PLC/DCS installation.	Witness	Lead	
5.06	PLC/DCS field testing OAT, SAT.	Witness	Lead	Witness
5.07	Operator interface stations (both in panel and desktop) related setup and configuration.	Witness	Lead	
5.08	Field PLC/DCS interfaces (HMIs).		Lead	
5.09	Communications			
5.10	Fiber patch panel procurement and installation.		Lead	

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
5.11	Ethernet switch procurement and installation.		Lead	
5.12	Copper patch panel procurement and installation.		Lead	
5.13	Uninterruptible power supply procurement and installation.		Lead	
5.14	Field Local Control Panels (LCPs)			
5.15	LCP procurement and fabrication.		Lead	
5.16	LCP installation.		Lead	
5.17	Local Operator Interfaces (LOIs)			
5.18	LOI procurement and fabrication.		Lead	
5.19	LOI installation.		Lead	
5.20	LOI programming.		Lead	Assist
6.00	Instruments and Control Valves			
6.01	Submittal and datasheets.		Lead	Support
6.02	Procurement.		Lead	Support
6.03	Installation.		Lead	Support
6.04	Setup and/or calibration.		Lead	Support
7.00	Electrical and Mechanical for Process Control System			
7.01	Building electrical provision and installation - cable/conduit/wire.		Lead	
7.02	Building mechanical provision and installation - including process instruments related tubing.		Lead	
7.03	Building wiring racks and supports (cable and/or conduit) - coordinated with power contractor where applicable.		Lead	
7.04	Building internal fiber-optic backbone conduit installation		Lead	

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
	(from building entrance/duct bank).			
7.05	Building internal communication wiring - DeviceNet, Modbus, Ethernet, etc. from PLC/DCS and/or patch panel.		Lead	
7.06	Electrical and mechanical installation inspection.	Witness	Lead	Assist
7.07	Vendor package - On/off skid-related electrical controls installation.		Lead	
7.08	Vendor package - On/off skid-related mechanical controls installation.		Lead	
7.09	Vendor package electrical and mechanical installation inspection.	Witness	Lead	Assist
7.10	Site fiber-optic backbone cable installation, termination, and certification testing.		Lead	
7.11	Network testing.	Witness	Lead	Assist
8.00	Process Start-Up			
8.01	Pre-operation and component test.	Witness	Lead	Assist
8.02	Loop checkout.	Witness	Lead	Assist
8.03	System Acceptance Test (SAT).	Witness	Lead	Assist
8.04	Operational testing.	Witness	Lead	Assist
8.05	Commissioning testing.	Lead	Assist	Assist
9.00	Process Closeout			
9.01	Redline drawings and/or electronic files submittal to Owner.		Lead	
9.02	As-builts (record set) - Update all drawings.		Lead	
9.03	Operation and maintenance manuals.		Lead	

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
9.04	Operational testing and commissioning sign-off forms.	Witness	Lead	Witness
9.05	Training.	Witness	Lead	
9.06	Commissioning (process performance testing).	Lead	Assist	Assist

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning.
- B. Owner Training:
 - 1. Demonstration requirements are specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.08 FIELD QUALITY CONTROL

- A. Inspection:
 - 1. Allow for inspection of PCIS installation as specified in Section 01_45_00 - Quality Control.
 - 2. Provide any assistance necessary to support inspection activities.
 - 3. Engineer inspections may include, but are not limited to, the following:
 - a. Inspect equipment and materials for physical damage.
 - b. Inspect installation for compliance with Drawings and Specifications.
 - c. Inspect installation for obstructions and adequate clearances around equipment.
 - d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
 - e. Inspect equipment nameplate data to verify compliance with design requirements.
 - f. Inspect cable terminations.
 - g. Inspect/witness instrument calibrations/verifications.
 - 4. Inspection activities conducted during construction do not satisfy inspection requirements specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.
- B. Instrument Installation Inspection:
 - 1. Provide any assistance necessary to support inspection activities.
 - 2. Inspections may include, but are not limited to, the following:
 - a. Inspect equipment and materials for physical damage.
 - b. Inspect the installed arrangement, lay lengths, orientation, piping obstructions, etc., that could affect the instruments accuracy or repeatability.
 - c. Inspect installation for compliance with Drawings and Specifications.
 - d. Inspect installation for obstructions and adequate clearances around equipment.
 - e. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
 - f. Inspect equipment nameplate data to verify compliance with design requirements.

- g. Inspect cable terminations.
 - h. Inspect/witness instrument calibrations/verifications.
 - 3. Inspection activities conducted during construction do not satisfy inspection requirements specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.
 - 4. Field acceptance testing: (Functional Testing) is specified in Section 40_80_01 - Commissioning for Instrumentation and Controls. Additional general requirements are specified in Section 01_75_17 - Commissioning.
- C. Installation supervision:
- 1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum, the ICSC shall provide the following services:
 - a. Installation resources:
 - 1) Coordinate with the Contractor regarding installation requirements of the Contract Documents.
 - b. Provide technical assistance to installation personnel by telephone:
 - 1) Furnish installation personnel with at least 1 copy of the accepted submittals, including all installation details.
 - c. Periodic inspections during the construction period.
 - d. A complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the Contract Documents.
 - e. Field verify accuracy and calibration of all instruments.

3.09 ADJUSTING

- A. Control valves:
 - 1. Stroke all control valves, cylinders, drives and connecting linkages from the control system as well as local control devices and adjust to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position.
 - 2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.
- B. Make all revisions necessary to the control system software, as directed by the Engineer.
 - 1. It is understood that the Contractor knows and agrees that changes will be required in the control system software during the Source Testing, Functional Testing, Process Operational Period, Process Start-Up, and during the Project Correction Period.

3.10 CLEANING

- A. As specified in Section 01_77_00 - Closeout Procedures.
- B. Vacuum clean all control panels and enclosures before process start-up and again after final completion of the project.
- C. Clean all panel surfaces.
- D. Return to new condition any scratches and/or defects.

- E. Wipe all instrument faces and enclosures clean.
- F. Leave wiring in panels, manholes, boxes, and other locations in a neat, clean, and organized manner:
 - 1. Neatly coil and label all spare wiring lengths.
 - 2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.
- G. As specified in other sections of the Contract Documents.

3.11 PROTECTION

- A. Protect all Work from damage or degradation until date of Substantial Completion.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_61_15

CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Contractor-developed loop description submittal requirements.
 - 2. General programming requirements.
 - 3. Common control functions:
 - a. General control and monitoring functions to be provided throughout the PCS system.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Clamp: Imposed upper and lower limits on setpoints to eliminate entries outside the allowable control parameters.
- C. Hardwired control: Control circuitry that does not utilize software to initiate functionality.
- D. Hardwired interlocks: A safety or protective feature that will interrupt operation of the equipment in all operating modes with no required operator intervention.
- E. Historize: To store data collected by a Supervisory Control and Data Acquisition system or Distributed Control system in a Historical Server or Historian for later use in trends and reports.
- F. Software interlocks: A safety or protective feature that will interrupt operation of the equipment when the PLC has control.
- G. Slew rate: Rate of change in respect to time.
- H. Watchdog timer: Timers imposed to test components such as discrete I/O to verify the health of the card.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. General programming requirements:
 - 1. Use variable names or aliases derived from tag and loop identification on the P&IDs for all process values.
 - a. Submit names for Owner approval.
 - b. Unless otherwise noted, utilize floating-point format for all PLC algorithms and calculations.
 - c. Provide PLC logic to convert raw input values into engineering units in a floating-point format.
 - 2. Store all adjustable parameters in the PLC and configure so that an operator with sufficient security access can change the parameters from the LOI or HMI. Update and display the current value at all locations, regardless of where the last change was made.
 - 3. Reusable PLC code blocks:
 - a. Develop and use new standard user defined function blocks (UDFBs) and user defined types (UDTs) where appropriate. One instance of each standard code block shall reside in each PLC and shall be referenced in main routines and subroutines.
 - b. New code blocks that the Contractor would like to use as a standard shall be submitted to Owner for review and approval.
 - 4. Documentation:
 - a. All control logic shall be completely annotated including all rungs, instructions, and tags.
 - b. Each routine shall have a title and a detailed description of the control strategy represented by the control logic. Where parameters are passed to the routine, all parameters shall be defined in the routine description.
 - c. Analog tag descriptions representing process variables shall include the engineering unit range of the analog variable.
 - d. Digital tag descriptions shall include the On and Off state labels.
 - e. Complete, grammatically correct sentences and terminology, consistent with water treatment processes, shall be utilized in the development of rung and routine descriptions.
 - f. All equations developed in the process logic shall be fully documented in the rung or routine description. A description of each constant and variable utilized in the equation shall be defined including engineering units.
 - 5. Program slew rates for setpoints as needed to limit the effect of updated setpoints on the process:
 - a. Provide for control setpoints and manual speed and position selections.

- b. Store new setpoints in one register, and gradually ramp the actual setpoint register at the slow rate until it reaches the new value.
 - c. Provide operator access to change slow rates from the HMI.
- 6. Saved setpoints:
 - a. Provide an operator selection to save all setpoint values.
 - b. Where possible use a DFB or AOI to provide an operator selection to restore all setpoints to the initial start-up value.
 - c. Provide an operator selection to restore all setpoints to the last saved value.
- 7. Store a copy of all adjustable parameters and accumulated and integrated totals in PCS:
 - a. Upon re-loading of the PLC program, re-load these values to the PLC from PCS or processor memory card.
 - b. PLCs provide a minimum 2 week data storage to provide for data accumulation and later communication to the Historian in the event of a network interruption.
- 8. Calculated values:
 - a. Program calculations such that division by zero errors cannot occur.
 - b. Prevent calculations from generating values that exceed the limits of the equipment or data type structures (integers) internal to the PLC.
 - c. Configure counting functions (start counts and operation counts) to allow a minimum of 10,000 counts, and to roll-over to zero at an even decimal interval (1 followed by 4 or more zeros).
 - d. Configure integrating functions to accurately accumulate the maximum rate from the instrument/equipment (totalizers, run time meters) for 30 years. Utilize manufacturer AOI/DFBs etc. where possible.
- 9. Timers:
 - a. Provide programmable settling and proving timers in control sequences as required for starting and stopping of equipment to allow the process to settle to a steady state before proceeding with any additional control functions.
 - 1) The settling timers may be overridden by setting the timer to 0 seconds.
- 10. Control Panel status:
 - a. Design the PLC system to function as a stand-alone unit that performs all of the control functions described in this Section completely independent from the functions of the PCS system PC-based operator interfaces:
 - 1) Failure of the PCS system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
 - b. Furnish a minimum of 1 screen that depicts the status of all enclosures containing PLCs, communication equipment, UPS or I/O in the control system, including but not limited to the following:
 - 1) PLC cabinet over-temperatures from high temperature switch.
 - 2) Intrusion status on all enclosures equipped with intrusion switches.
 - 3) AC power failure:
 - a) Monitor ahead of UPS.
 - 4) DC power supply failure:
 - a) For redundant power supplies, alarm when either power supply or the diode bridge fails.
 - 5) UPS failure signal.

- 6) UPS Low Battery signal.
- 7) Digital bus network Coupler and or Gateway failure signal.
- 8) Ethernet Switch failure signal.
- 11. PLC system communication status:
 - a. Furnish a minimum of 1 screen to display all communication errors and status within the PCS:
 - 1) Communication between PCS and PLCs, PLC to PLC, PLC to RIO and PLC and or PCS to VCP.
 - 2) 4-20 mA HART interface cards.
 - 3) Digital bus network status:
 - a) Profibus scanners.
 - 4) Modbus Gateway modules.
 - 5) Display status of each node, and summary of failures over the past 60 minutes.
 - b. Generate a communications alarm if any communication fault is detected or there is no response from a node for more than a user specified time.
 - c. In the event of communications loss:
 - 1) Continue normal operation at each PLC.
 - 2) Where control parameters are received over a communications link:
 - a) If a link fails where process elements use the remote value for closed-loop control, hold operating status, speed and position, of the process elements at their last state before the communication alarm, unless other I/O local to that PLC indicates shutdown or over-ride conditions:
 - (1) Ensure that the operator can control the process using PC\IS HAND mode at the local LOI.
 - b) If a link fails where process elements use the remote value to determine setpoints, continue to operate using the last value received:
 - (1) Provide a manual over-ride entry at the local LOI to allow an operator to enter a different value for any such remote signal.
 - (2) Generate an alarm whenever an over-ride value is in use.
- 12. 4-20 mA Hart interface cards:
 - a. Provide the following HART protocol information for each populated channel on the card:
 - 1) Process variable values:
 - a) Primary process variable (analog): 4-20 mA current signal.
 - b) Primary process variable (digital): Digital value in engineering units.
 - c) Percent range: Primary process variable expressed as percent of calibrated range.
 - d) Loop current: Loop current value in milliamps.
 - e) Secondary process Variable 1: Digital value in engineering units available from multivariable devices (if applicable).
 - 2) Host commands:
 - a) Set primary variable units.
 - b) Set upper range.
 - c) Set lower range.
 - d) Set damping value.

- e) Set message.
 - f) Set tag.
 - g) Set date.
 - h) Set descriptor.
 - i) Perform loop test: Force loop current to specific value.
 - j) Initiate self-test: Start device self-test.
 - k) Get more status available information.
- 3) Status and diagnostic alerts:
- a) Device malfunction: Indicated device self-diagnostic has detected a problem in device operation.
 - b) Configuration changed: Indicates device configuration has been changed.
 - c) Cold start: Indicates device has gone through power cycle.
 - d) More status available: Indicates additional devices status data available.
 - e) Primary variable analog output fixed: Indicates device in fixed current mode.
 - f) Primary variable analog output saturated: Indicates 4-20 mA signal is saturated.
 - g) Secondary variable out of limits: Indicates secondary variable value outside the sensor limits.
 - h) Primary variable out of limits: Indicates primary variable value outside the sensor limits.
- 4) Device identification:
- a) Instrument tag: User defined, up to 8 characters.
 - b) Descriptor: User defined, up to 16 characters.
 - c) Manufacturer name (code): Code established by HCF and set by manufacturer.
 - d) Device type and revision: Set by manufacturer.
 - e) Device serial number: Set by manufacturer.
 - f) Sensor serial number: Set by manufacturer.
- 5) Calibration information:
- a) Date: Date of last calibration, set by user.
 - b) Upper range value: Primary variable value in engineering units for 20 mA point, set by user.
 - c) Lower range value: Primary variable value in engineering units for 4 mA point, set by user.
 - d) Upper sensor limit: Set by manufacturer.
 - e) Lower sensor limit: Set by manufacturer.
 - f) Sensor minimum span: Set by manufacturer.
 - g) PV damping: Primary process variable damping factor, set by user.
 - h) Message: Scratch pad message area (32 characters), set by user.
 - i) Loop current transfer function: Relationship between primary variable digital value and 4-20 mA current signal.
 - j) Loop current alarm action: Loop current action on device failure (upscale/downscale).
 - k) Write protect status: Device write-protect indicator.

- C. Common control functions:
1. Incorporate common control functions into all control loops and devices and into the control programming, whether or not specifically shown in the specific control descriptions or elsewhere in the Contract Documents.
 2. Alarms:
 - a. Generate alarms within the PLC logic.
 - b. Indicate alarms at the LOI and HMI. Enable acknowledgement from either the HMI or the LOI.
 - c. Generate high, high-high, low, and low-low level alarms where indicated:
 - 1) Provide an alarm reset deadband for each analog value to prevent excessive repeated alarms.
 - 2) Provide logic and timers to inhibit analog alarms based on process events. For example, inhibit low flow alarms when a pump is stopped, or has not been running long enough to establish flow.
 - d. Flash all alarm and fail conditions and their respective indicators on the PCS graphic screens and local indicating lights until the condition is acknowledged by the operator, even if the alarm condition is no longer present.
 - e. Once the alarm is acknowledged by an operator, display alarm conditions in a steady state (not flashing) while the alarm condition is still present:
 - 1) Flash with a cycle rate of 1/2 second on and 1/2 second off.
 - f. Once the alarm has been cleared and the operator has acknowledged the alarm or fail condition, turn the graphic alarm indicator off.
 - g. For all alarms that do not have inherent timers, provide an operator-adjustable proving timer to limit nuisance alarms, continuously adjustable from zero seconds to 100 minutes. The initial setting of proving timers shall be zero seconds:
 - 1) The PLC shall start the timer when it first detects an alarm condition and shall only activate the alarm after the timer has expired.
 - 2) If the alarm condition clears while the timer is running, the timer shall reset, and the alarm shall not be activated.
 - h. Use interlocks and proving timers to prevent alarms from operating due to power loss, except for loss of power alarms.
 - i. Furnish an alarm silence pushbutton at each PCM, LOI, or LCP with an audible alarm to signal the PLC to turn off the audible alarm until the next alarm occurs.
 - j. Lamp test: Furnish lamp test pushbuttons at each control panel with more than 10 pilot lights, that illuminates all pilot lights on the panel:
 - 1) The lamp test may sequence through blocks of lights.
 - 2) Minimum on time for each lamp during lamp test 15 seconds.
 - k. Horns and Beacons:
 - 1) Activate PCM horn and beacon on all critical alarms and on other alarms as defined by the Facility Alarm Philosophy.
 - 2) Deactivate PCM horn and beacon when PCM reset pushbutton is activated.
 - 3) Silence PCM horn when PCM silence pushbutton is activated.

- I. Dual analog instruments:
 - 1) For applications where 2 or more analog instruments are measuring the same process variable:
 - a) Generate an operator adjustable percent deviation alarm.
 - b) Allow operator to take each instrument out of service when an instrument is out of service.
- 3. Where a reset is shown for counts, totals and times maintained in the PLC:
 - a. Provide a reset selection on the HMI screen that displays the value.
 - b. Provide a preset function on the HMI to allow an operator-entered value to become the current accumulated total.
 - c. Limit access to the reset and preset functions to operators with suitable security level.
 - d. Log the value before reset, operator, time, and date of reset in the PCS archive.
 - e. Log the value before preset, preset value, operator, time, and date of preset in the PCS archive.
- 4. Where start counts are indicated on the Drawings, or required in this Section, count starts for each piece of equipment (off to on transitions of running status) in the PLC:
 - a. Display total starts on PCS screens and provide a reset function.
 - b. Where indicated, calculate number of starts for each day:
 - 1) Display current day and previous day starts on PCS displays.
 - 2) Do not reset daily start count when overall count is reset.
 - 3) Archive starts for each day through PCS.
- 5. Where run time accumulation is indicated on the Drawings, or required in this Section, integrate accumulated run time to the nearest 0.1 hour whenever the running status input indicates that the equipment is running:
 - a. Display total run time in hours on PCS screens.
 - b. Where indicated, calculate total run time for each day:
 - 1) Display current day and previous day run time on the HMI to the nearest 0.1 hour.
 - 2) Do not reset daily run time when overall time is reset.
 - 3) Archive run time for each day through PCS.
- 6. For all monitored analog values:
 - a. Convert all values to engineering units in floating-point format within the PLC.
 - b. Maintain trends in PCS.
 - 1) Display minima and maxima on the HMI, and archive through PCS.
 - c. Flows and Weights:
 - 1) Totalize flows in the PLC logic:
 - 2) Where totalized flows are input to a discrete input, count input pulses and multiply by the volume per pulse.
 - 3) Where no totalizer input is shown, integrate the analog input over time.
 - 4) Display totals on the HMI and LOI.
 - 5) Archive totals to the historical database through PCS.
 - d. Generate an alarm whenever an over-ride value is in use.
 - e. Calculate hourly, daily, and monthly averages:
 - 1) Calculations shall be performed by the PLC.

- 2) Display averages on the HMI, and archive through PCS.
 - 3) Display minima and maxima on the HMI, and archive through PCS.
- f. Calculate minimum and maximum values each day, and month:
 - 1) Calculations may be performed by the PLC or PCS.
 - 2) Display minima and maxima on the HMI, and archive through PCS.
- g. Generate an alarm whenever an over-ride value is in use.
- 7. Analog data processing:
 - a. Engineering units conversion:
 - 1) Use engineering units for all analog point values. Convert analog inputs to engineering units.
 - b. Analog magnitude checking:
 - 1) Provide upper and lower limits to prevent operator-entered values (setpoints, etc.) from falling outside acceptable limits.
 - c. Analog value quality:
 - 1) Monitor analog values received at each PLC from analog inputs or communications from another PLC or RIO specific to critical analog values, and generate alarms for the following conditions:
 - a) Rate of change in excess of acceptable limit:
 - (1) Provide a separate rate limit for each value.
 - b) Stale value:
 - (1) For analog signals that come from analog inputs or calculations using analog inputs, which are expected to have some variation each time the input is read, alarm when there is no change in the value for 10 times the normal expected scan or communication update.
- 8. Analog device override (LOI and HMI):
 - a. Provide the following functions from the HMI and the local LOI all controlling analog input:
 - 1) An over-ride value to be used in place of the analog input:
 - a) Enter in engineering units:
 - (1) Display the calibrated range in engineering units.
 - (2) Only allow entries within the calibrated range of the instrument.
 - b) When the analog input is enabled, track the analog input so that the over-ride matches the analog input value when the input is initially disabled.
 - c) Maintain over-ride status and value in the PLC.
 - d) Only allow access to over-ride selections and settings to operators with sufficient security.
 - 2) An enable/disable selection:
 - a) When enabled, the value used by the PCS system is equal to the analog input value.
 - b) When disabled, the analog input is ignored, and the over-ride value is used for all control and display functions.
 - c) Generate an alarm whenever an analog input is disabled.
 - d) Enter a value for the analog input from the PCS system to the PLC.
 - 3) Use the over-ride value for all display and control functions instead of the actual analog input value.

- b. Provide the following functions in the PLC, with selections and value entry from the HMI and/or LOI:
 - 1) An over-ride value to be used in place of the normal output value:
 - a) Enter in percent of output span.
 - b) When the analog output is enabled, track the analog input so that the over-ride matches the analog output value when the output is initially disabled.
 - 2) An enable/disable selection:
 - a) When enabled, the value sent to the output is the value determined by the PLC based on the control logic or operator-entered value in PCS HAND.
 - b) When disabled, the calculated PCS HAND values are ignored, and the over-ride value is sent to the output.
 - c) Generate an alarm whenever an analog output is disabled.
- 9. Tank and vessel levels:
 - a. Display all tank and vessel levels as both a level (typically in feet) and a volume (typically in gallons):
 - 1) Some individual displays may be only level or volume, when agreed to by the Owner and Engineer during screen review meetings.
 - b. Monitor rate of change of volume on all tanks and vessels:
 - 1) Establish the maximum withdraw rate at which the volume should decrease (all pumps or feeders operating at maximum output). Generate an alarm whenever the volume decreases faster than this rate.
 - 2) Establish the maximum fill rate at which the volume should increase when filling. Generate an alarm whenever the volume increases faster than this rate. Verify tank and vessel level is fluctuating to verify the validity of the IO register. If it is determined the register is not active or failed in a manner that leaves a stagnant value generate an alarm.
- 10. I/O filtering and processing:
 - a. Analog input filtering:
 - 1) For each analog input provide an adjustable first order filter, for the purpose of smoothing out spikes and other noise for analog transmitter input signals. By default, configure analog inputs with no filtering affect.
 - 2) Monitor analog input signal quality:
 - a) Over range: The input value is above the normal range (typically over 21 mA).
 - b) Under range: The input value is below the normal range (typically under 3 mA, indicating a probable broken connection).
 - c) Generate alarms for over or under range inputs.
 - d) Do not use over or under range values for control or calculation purposes:
 - (1) Where a second instrument is provided to monitor the same condition (a redundant instrument, or additional instruments furnished for averaging or different operating modes), and has a valid signal, use that input for control.
 - (2)

- 3) Digital input filtering (proving timer):
 - a) Provide an adjustable time delay function (0-10 seconds) on discrete input for the purpose of de-bouncing.
 - b) By default, discrete inputs shall be configured with de-bounce timers set to zero seconds.
11. Instrument scaling (HMI/LOI):
 - a. Provide 1 or more maintenance screens to display ranges and trigger points for all field instruments:
 - 1) For analog instruments, use input scaling values in the PLC to determine minimum and maximum calibration points.
12. PCS HAND-OFF-AUTO:
 - a. Where indicated, provide HAND-OFF-AUTO and START-STOP selections in the PCS, accessed from an LOI or HMI for operators with sufficient security, to provide the following operating modes:
 - 1) PCS AUTO: The normal, automatic control mode of the strategy which allows full PLC control in response to process conditions and programmed sequences.
 - 2) PCS HAND: Enables PCS Manual control where control decisions are made by an operator through the PCS START-STOP, OPEN/CLOSE, or other selections as indicated.
 - 3) PCS OFF: Automated PCS control is disabled, and PLC calls for all associated equipment to stop and valves to close or go to their identified safe state.
 - 4) Program the PLC so that switching a strategy between AUTO and HAND (either direction) occurs with a smooth transition. Keep running or position status unchanged when control is switched to HAND until a change is requested using the operator selections (START, STOP, OPEN, CLOSE). Keep running and position status unchanged when control is switched to AUTO until the control logic determines a change is required.
13. Display the current status of all operator selections (PCS HAND/AUTO, PCS START/STOP, etc.) on LOI and HMI.
14. Interlocks:
 - a. Implement software interlocks where indicated to place equipment in a safe condition in response to impending hazardous process conditions. Apply software interlocks when equipment is operating in PCS AUTO or PCS HAND:
15. Permissives:
 - a. Implement software permissives where indicated to prevent equipment from starting in an unsafe condition.
 - b. Apply software permissives when equipment is operating in PCS AUTO or PCS HAND.
16. Process control algorithms:
 - a. Jog and hold: Unless otherwise indicated, use jog and hold control algorithms where possible:
 - 1) When the error between process variable and setpoint is beyond a setpoint deadband:
 - a) Jog valve or ramp speed in the required direction for a preset "Jog Time" or until the process variable reaches or passes the setpoint.

- b) Then hold speed or position through a setpoint "Hold Time".
 - c) Continue alternating jog and hold until the error is less than the deadband.
 - 2) Provide operator access to Jog Time and Hold Time setpoints from the HMI.
- b. PID algorithms: Use where indicated, or where necessary to provide fast response:
 - 1) Provide a PID faceplate with the following displays and functions for each PID control algorithm:
 - a) Display Output, CV.
 - b) Display Setpoint, SP.
 - c) Display Process Variable, PV.
 - d) Allow for operator selection of Automatic or Manual control of the output.
 - e) Under Manual control of output allow the operator to enter the desired output value.
 - f) Allow for input of the 3 Proportional, Integral, and Derivative tuning parameters.
 - g) Configure PID loops to prevent reset windup when controlled equipment is operating in Manual (local or PCS), or when the equipment has reached a physical limit.
 - h) When controlled equipment is being operated in remote PCS HAND, configure the PID function to track the process variable to provide a smooth transfer between Manual and Automatic modes.
 - i) Provide selectable slew rates with adjustable setpoints to allow the PID algorithm to slowly ramp to its final value to minimize system disturbance.
- 17. Equipment alternating and sequencing:
 - a. Distribute number of starts and run time equally between identical equipment.
 - a. Where multiple pieces of equipment are used to control a single process variable, alternating of lead and lag equipment assignments is done as follows:
 - 1) Automatic Lead/Lag equipment selection:
 - a) The control system automatically selects the lead equipment and next lag equipment based on the lowest run time hours of the equipment.
 - b) When multiple equipment are running, the control system determines which equipment to stop next based on the running equipment with the highest run time hours.
 - c) A weighted run time factor can be assigned to each individual piece of equipment.
 - (1) The weighting factor is a percentage from 1-100 percent that is multiplied by the actual run time hours of the equipment to create a weighted run time hours of the equipment.
 - (2) The weighted run time hours of each piece of equipment are then used by the algorithms that select the equipment that will start or stop next.

- (3) This is to allow for specific equipment to accrue more run time hours so that all pumps do not reach their maximum run time hours at approximately the same time:
 - (a) Display both the weighted and actual runtime hours on the PCS screen.
 - 2) Manual Lead/Lag selection:
 - a) The operator will assign the Lead, "Next Lag" equipment through a selection matrix in the HMI.
 - b) When modifying this matrix, modifications shall not become active until an "ACCEPT ALL" software pushbutton is activated.
 - c) Provide a "CANCEL ALL" software pushbutton to clear all modification of the selection matrix and revert them to the last accepted changes.
- 18. Motor control:
 - a. Monitor the device's LOCAL-OFF-REMOTE (LOR) switch (the hard-wired switch at the MCC, drive or equipment) to determine when the PLC has control of the associated equipment:
 - 1) Display current REMOTE status on the PCS screens.
 - b. Monitor the device's running status from the starter auxiliary or run status input:
 - 1) Display the current status (running or stopped) on the PCS screens.
 - 2) Use status to calculate total run time and daily run time, and to count total starts and daily starts.
 - 3) Provide time stamp for each start.
 - 4) For motors 200 HP and greater, provide software to prevent exceeding the manufacturer's recommended maximum starts per hour.
 - c. When equipment control has been given to the PLC as reported by the LOCAL-OFF-REMOTE switch, allow selection of PCS AUTO or PCS HAND control modes based upon operator selection using the PCS screens.
 - d. Starting, stopping and running when the device LOR is in LOCAL:
 - 1) With the LOR switch in the LOCAL position, the motor is controlled by the START and STOP pushbuttons.
 - 2) With the LOR switch in the OFF position, the motor is prohibited from running.
 - 3) With the LOR switch in the REMOTE position, the motor is controlled remotely.
 - e. Starting, stopping and running when the device LOR is in REMOTE:
 - 1) When the motor is expected to be running (PLC has issued a START or RUN due to process conditions or operator selection), LOR is in REMOTE, and the device is not reported to be running, start an operator adjustable "Control Activation" timer:
 - a) Provide "Control Activation" timers for each piece of controlled equipment:
 - (1) If the LOR and required running status do not change, and the PLC does not receive running status within the "Control Activation" time period:
 - (a) De-activate the output.

- (b) Place the device in a "Failed" state.
 - (c) Generate a "Failed to Respond" alarm.
- 2) When the motor is not expected to be running (PLC has issued a STOP or removed the RUN output), LOR is in REMOTE, and the device is reported to be running, start the "Control Activation" timer:
 - a) If the LOR and required stopped status do not change, and the PLC does not lose the running status within the "Control Activation" time period:
 - (1) Keep the RUN output off or the STOP output on.
 - (2) Place the device in a "Failed" state.
 - (3) Generate a "Failed to Respond" alarm.
- 3) Re-establish PLC control of a device in a "Failed" state only after the following:
 - a) An operator turns the device's LOR switch out of REMOTE, and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).
- f. Where motor winding high temperature switches or RTD temperature elements are shown, generate an alarm when high temperature is sensed (contact opens or temperature above the high alarm setpoint), but do not stop the motor unless otherwise indicated.
- g. Motor equipped with current detection shall shut down and report a "failed" status on detection of high current.
- h. Control two-speed motors similar to other motors, except as listed below:
 - 1) Motor states are RUN-FAST, RUN-SLOW, and STOP.
 - 2) Start all two-speed motors in the RUN-SLOW state. If or when the high speed is required (RUN-FAST operator selection or process conditions), transition to RUN-FAST after a designated time.
 - 3) When transitioning from RUN-FAST to RUN-SLOW, remove the RUN-FAST output or issue a STOP, then wait for a "Fast to Slow" time delay before energizing the RUN-SLOW or START-SLOW output.
- i. Speed control:
 - 1) Modulate speed on VFD-driven motors using jog and hold, or PID control algorithms to maintain process conditions as described in the specific loop descriptions.
 - 2) Operate speed control within a pre-defined range:
 - a) Minimum speed as determined by equipment manufacturer. The higher of:
 - (1) Minimum motor speed to maintain adequate cooling for the type of load driven (constant or variable torque).
 - (2) Minimum equipment speed, such as minimum speed to deliver flow or to deliver minimum flow for equipment cooling or lubrication.
 - b) Maximum speed 100 percent (60 hertz) or as identified by equipment manufacturer.
 - 3) Where multiple equipment may operate together to maintain the same process condition, alternatively referred to as "Lead/Lag":
 - a) Start the first equipment at a preset starting speed.

- b) When 1 or more equipment is running and the speed control algorithm reaches a preset “Start Next” speed value (initially 95 percent of speed range) through a preset time delay:
 - (1) Start the next available equipment at the preset starting speed.
 - (2) Ramp up the started equipment and ramp down the previously running equipment to the mid operating speed (adjustable in the PLC). Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with the new load running at the mid speed (for example if one pump is running and the second pump will be added, then the total flow of both pumps running at mid operating speed should be approximately the same as flow of one pump at Start Next speed).
 - (3) Once both equipment reach the mid operating speed, resume the speed control algorithm for those equipment.
 - (4) Operate all equipment at the same speed following the output of the speed control algorithm.
 - c) When two or more pieces of equipment are running, monitor for a “Stop Next” condition:
 - (1) Where flow rate is monitored, use a preset “Stop Next” flow rate for each possible number and combination of equipment:
 - (a) Determine initial “Stop Next” speed based on the flow that can be provided with one fewer piece of equipment running at a speed slightly below the “Start Next” speed.
 - (2) When the “Stop Next” condition exists through a preset time delay:
 - (a) Ramp speed of running equipment except for the equipment to be stopped up to a preset value based on the number of items running. Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with one fewer load running (typically slightly below the preset “Start Next” speed) while ramping speed of equipment to be stopped down to the preset minimum speed.
 - (b) Operate all remaining equipment at the same speed following the output of the speed control algorithm. Stop the load once it reaches minimum speed.
- 19. Gate and valve control:
 - a. Monitor the device’s LOCAL-STOP-REMOTE (LSR) switch(es) (the integral switch in the actuator or hard-wired switch at the local control station):
 - 1) Display current REMOTE status on PCS screens.

- b. Start an "Open Activation" timer whenever the device is expected to be open (PLC has issued an OPEN command in PCS AUTO, or OPEN was selected in PCS HAND):
 - 1) Initially set "Open Activation" time to twice the normal opening time.
 - 2) If the LSR position and open command do not change, and the PLC does not receive fully open status feedback within the "Open Activation" time period:
 - a) De-activate the open output.
 - b) Place the device in a "Failed" state.
 - c) Generate a "Failed to Open" alarm.
- c. Start a "Close Activation" timer whenever the device is expected to be closed (PLC has issued a CLOSE command in PCS AUTO, or CLOSE was selected in PCS HAND):
 - 1) Initially set "Close Activation" time to twice the normal closing time.
 - 2) If the LSR position and close command do not change, and the PLC does not receive fully closed status feedback within the "Close Activation" time period:
 - a) De-activate the close output.
 - b) Place the device in a "Failed" state.
 - c) Generate a "Failed to Close" alarm.
- d. Limit the number of open/close /commands so that it does not exceed the manufacturer requirements.
- e. For modulating valves (valves controlled from either a 4-20 mA signal or digital communications command) with position feedback, start a "Position Error" timer whenever the position feedback differs from the required position command by more than a setpoint error when the LSR is in REMOTE:
 - 1) For analog modulating devices, error is determined by position feedback differing from position command by more than the setpoint error.
 - 2) For discrete modulating devices, error is determined by feedback not changing in the correct direction, or changing at less than a setpoint rate, when the OPEN or CLOSE PLC output is active.
 - 3) Initially set the "Position Error" time to 60 seconds.
 - 4) If the LSR position does not change, and position error stays outside of the setpoint error through the "Position Error" time period:
 - a) Place the device in a "Failed" state.
 - b) Generate a "Position Fail" alarm.
- f. Provide separate time delay settings for each function and for each device.
- g. If the valve position inputs indicate an invalid state (i.e., valve open and closed at the same time), place the device in a "Failed" state and generate an "Invalid State" alarm.
- h. Re-establish PLC control of a device in a "Failed" state only after one of the following:
 - 1) An operator turns the device's LSR switch out of REMOTE and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).
 - 2) An operator acknowledges the fault from PCS.
- i. For all alarm conditions, control other devices (as stopping pumps, etc.) as stated in the individual loop descriptions to make the system safe.

- j. For discrete modulating valves (valves positioned to intermediate positions to control process values through discrete OPEN and CLOSE outputs), count the number of actuations (OPEN or CLOSE commands) per hour in the PLC:
 - 1) Display count on the HMI.
- 20. Chemical systems (LOI/HMI):
 - a. Provide the following chemical system screens:
 - 1) Where one LOI manages more than one chemical system, a main menu screen that will allow the operator to access the individual chemical system screens using software keys.
 - 2) One or more screens for each individual chemical system controlled at that location, containing:
 - a) All status displays (running, failed, etc.).
 - b) Selections (lead/lag, which process flow to pace to, etc.).
 - c) Setpoint entry and display.
 - d) Calculated feed requirement (result of flow pacing calculation) in engineering units (typically milligrams of chemical per minute).
 - e) Output signal to feeder in percent of full span.
 - f) Actual chemical flow rate from flowmeter (where shown).
 - g) Process flow rate(s) used to pace each chemical on the individual chemical screens (PROC FLOW):
 - (1) Where different process flows can be selected for flow pacing, display and identify the selected source.
 - b. Chemical system calculations: Perform calculations as indicated on the Drawings and in the individual loop descriptions. Use the following assumptions, unless otherwise noted:
 - 1) Where chemical flow feedback is not used, assume feeder output is linear in response to control signal.
 - 2) Zero signal (typically 4 milliamperes) produces zero flow.
 - 3) Perform flow-pacing calculations using as indicated on the Drawings or described in the individual loop descriptions.
 - c. Provide the setpoints and selections indicated on the Drawings and in the individual loop descriptions. Typical setpoints include:
 - 1) QMAX: Maximum calibration value:
 - a) Chemical flow rate measured from calibration column at maximum feeder output (typically in gallons of solution per hour or milliliters of solution per minute).
 - 2) CONC: Chemical concentration:
 - a) The concentration of the chemical in the solution to be fed, in engineering units (typically milligrams of chemical per liter of chemical solution).
 - 3) DENSITY:
 - a) Density of the chemical solution to be fed in engineering units or as a specific gravity.
 - b) Used to calculate the concentration of the chemical in the solution.
 - 4) DOSE: Desired dosage:
 - a) Desired chemical concentration in the process stream in engineering units (typically milligrams of chemical per liter of process fluid).

- 5) FLOW SEL: Selection of process stream(s) for flow pacing.
 - 6) OPEN/CLOSED LOOP:
 - a) Selection of method of controlling chemical flow-paced feed rate.
 - b) OPEN LOOP: Signal to feeder is based on feeder calibration (QMAX) to deliver calculated chemical solution feed rate. Chemical solution flowmeter is not used for control.
 - c) CLOSED LOOP: Chemical feed rate is directly controlled using the calculated chemical solution feed rate as the setpoint, and the flow rate from the chemical solution flowmeter as the process variable.
 - 7) TRIM FACTOR: refer to the equations below.
- d. Chemical control algorithms:
- 1) Flow pacing algorithm: Operator selects a desired dose and the control system adjusts the chemical feed rate to dose based on process flow, chemical concentration, and feeder calibration. The calculation is as follows (units may vary from those shown in the calculation below):

$$Q_c = \frac{D \cdot Q_f \cdot 8.34}{24 \cdot C \cdot p}$$

Where,

Q_c = Chemical Pump flow Rate command (gal/hr)

Q_f = Process Flow (MGD) Measurement

D = Dose setpoint (mg/L) User Adjustable

p = Chemical Density (lbs/gal)

C = Chemical Concentration (ratio)

8.34 = conversion factor ([lbs • L]/[MG • day • mg])

24 = conversion factor days to hours

$$S = \frac{Q_c}{Q_{max}}$$

Where,

S = Pump Speed control setpoint (0 to 100%)

Q_c = Flow setpoint from equation above (gal/hr)

Q_{max} = Maximum Pump Flow setpoint (gal/hr) based on calibration column test.

- 2) Flow pacing with closed loop algorithm: Operator selects a desired dose and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a flow rate setpoint. This flow rate setpoint shall be derived from the process flow and operator setpoints for dosage and concentration. The calculation is as follows (units may vary from those shown in the calculation below):

$$Q_c = \frac{D \cdot Q_f \cdot 8.34}{24 \cdot C \cdot p}$$

Where,

Q_c = Chemical Pump flow Rate command (gal/hr)

Q_f = Process Flow Measurement (MGD)

D = Does setpoint (mg/L) User Adjustable

p = Chemical Density (lbs/gal)

C = Chemical Concentration (ratio)

8.34 = conversion factor ([lbs • L]/[MG • day • mg])

24 = conversion factor days to hours

a) The speed of the chemical feed pump shall be determined by the output of a PID controller. The setpoint of the PID controller shall be the result of the equation in the paragraph above. The process variable (feedback) shall be the chemical flow (not process flow) as measured by a flow meter.

- 3) Flow pacing with analyzer trim algorithm: Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the chemical feed rate to dose based on process flow, chemical concentration, process analyzer output, and feeder calibration. The calculation is as follows (units may vary from those shown in the calculation below):

$$Q_c = \left(\frac{D \cdot Q_f \cdot 8.34}{24 \cdot C \cdot p} \right) T$$

Where,

Q_c = Chemical Pump flow Rate command (gal/hr)

Q_f = Process Flow Measurement (MGD)

T = Trim Factor (ratio)

D = Does setpoint (mg/L) User Adjustable

p = Chemical Density (lbs/gal)

C = Chemical Concentration (ratio)

8.34 = conversion factor ([lbs • L]/[MG • day • mg])

24 = conversion factor days to hours

$$S = \frac{Q_{CL2}}{Q_{max}}$$

Where,

S = Pump Speed control setpoint (0 to 100%)

Q_{CL2} = Flow setpoint from equation above (gal/hr)

Q_{max} = Maximum Pump Flow (gal/hr) based on calibration column test.

a) The trim multiplier shall be controlled by the output of a PID controller initially scaled between 0.8 and 1.2, adjustable. The setpoint of the PID controller shall be an operator adjustable target residual or desired analytical value. The process variable (feedback) of the PID controller shall be measured residual or analytical value.

- 4) Flow pacing with closed loop and analyzer trim algorithm: Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a flow rate setpoint. An additional control algorithm is used in the calculation to fine-tune the feed based on an analytical measurement as measured by the process analyzer.

$$Q_c = \left(\frac{D \cdot Q_f \cdot 8.34}{24 \cdot C \cdot p} \right) T$$

Where:

Q_c = Chemical Pump flow Rate command (gal/hr)

Q_f = Process Flow Measurement (MGD)

T = Trim Factor (ratio)

D = Does setpoint (mg/L) User Adjustable

p = Chemical Density (lbs/gal)

C = Chemical Concentration (ratio)

8.34 = conversion factor ([lbs • L]/[MG • day • mg])

24 = conversion factor days to hours

- a) The trim multiplier shall be controlled by the output of a PID controller initially scaled between 0.8 and 1.2, adjustable. The setpoint of the PID controller shall be an operator adjustable target residual or desired analytical value. The process variable (feedback) of the PID controller shall be measured residual or analytical value.
 - b) The speed of the chemical feed pump shall be determined by the output of a PID controller. The setpoint of the PID controller shall be the result of the equation in the paragraph above. The process variable (feedback) shall be the chemical flow (not process flow) as measured by a flow meter.
21. Breaker status:
- a. Display the following data to the extent it is available from the specified device:
 - 1) Open.
 - 2) Closed.
 - 3) Tripped.
 - 4) Ground fault.
 - 5) Settings.
 - 6) Racked out.
22. Power Data:
- a. Retrieve data from:
 - 1) Power Quality Meters (PQMs) at 480V.
 - 2) Main Breaker Protective Relays on 12.47 kV Switchgear.
 - 3) Generator Master Control Panel.
 - 4) Digital bus networks, as indicated.
 - 5) Where available, use EtherNet IP communications.
 - b. Display the following data (to the extent it is available) from the specified device.
 - 1) Current XXXX.X A:
 - a) A-Phase.
 - b) B-Phase.
 - c) C-Phase.
 - 2) Volts: XXXX.X V:
 - a) A-Phase.
 - b) B-Phase.
 - c) C-Phase.
 - 3) Reactive power: XXXX.X kVAR.
 - 4) Real power: XXXX.X kW.
 - 5) Apparent power: XXXX.X kVA.
 - 6) Power factor: 0.XX.

- 7) Energy: XXXXXXXX kW*hr.
 - 8) Demand peak: XXXX Amp.
 - 9) Demand peak: XXXX kW.
- c. For engine/generator system monitoring, also display percent of rated output.
- 23. Power Supply and Distribution displays Power Quality Meters display:
 - a. In addition to the Power Data listed above, display the following (where available) from PQMs, Protective Relays, and Generator Master Control Panel:
 - 1) Frequency: Hertz.
 - 2) THD (current and voltage): up to 31st harmonic.
 - b. Calculate, indicate, historize, and trend data in a 12.47 kV Meter Table that lists measurements from the following Protection Relays:
 - 1) Protection Relay on 52-G1.
 - 2) Protection Relay on 52-G2.
 - 3) Protection Relay on 52-M1.
 - 4) Protection Relay on 52-M2.
 - 5) Protection Relay on 52-M3.
 - 6) Display calculated values for "Load At 12.47 kV", which sums the current, kW, and kW-hr values for all five Protection Relays.
 - 7) Display calculated values for "Load At 480V", which sums the current, kW, and kW-hr values for all PQM meters.
 - 8) Display calculated values for "Transformer and Line Losses", which subtracts "Load at 480V" from "Load At 12.47 kV" for current, kW, and kW-hr values for all PQM meters.
 - c. Display the data in a 480V Meter Table that lists measurements from all power quality meters on the plant.
- 24. Digital bus Starters, RVSS and VFDs equipped with EtherNet IP communications:
 - a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below.
 - b. Communicate start and stop commands and receive running feedback over the fieldbus network.
 - c. Provide data entry screen for the cost of electricity in dollars per (kw*hr), which will be used in calculations for display.
 - d. Monitor the following additional values, and display on the HMI:
 - 1) Motor current, phase A, B, and C.
 - 2) Over current alarm.
 - 3) Under current alarm.
 - 4) Running status.
 - 5) Phase loss.
 - 6) Stall.
 - 7) Number of starts.
 - 8) History of past 5 trips.
 - e. Calculate, indicate, historize, and trend, the following additional values:
 - 1) Full Load Amps (static value, Engineer will provide).
 - 2) Average Motor Operating Current.
 - 3) Run Time (Hours).
 - 4) Operating Hours (Hours/Year).

- 5) Average Load Factor (equals Average Motor Current Operating Current/Full Load Amps) - *display as a percentage*.
- 6) Annual Energy Use (kW*hr).
- 7) Annual Operating Cost (dollars).
- 8) Percent of Site Electric Use (equals Annual Energy Use/Sum of Annual Energy (kW*hr) values for all PQM meters).
- f. For Variable Frequency Drives:
 - 1) Speed command.
 - 2) Speed feedback.
- g. For RVSS, Variable Frequency Drives, and where otherwise shown or available, monitor the following over the digital bus network:
 - 1) Line voltage.
 - 2) Power.
 - 3) Power factor.
 - 4) Over voltage alarm.
 - 5) Under voltage alarm.
 - 6) Over current alarm.
 - 7) Under current alarm.
 - 8) Indicate, historize, trend, and alarm data as indicated in the ACS I/O Tables on the Drawings.
25. Calculate, indicate, historize, and trend plant-wide calculated values for kW by the following Groups.
 - a. Calculated values (summed from starter data for all equipment within the Groups identified below):
 - 1) Demand peak: XXXX Amp.
 - 2) Demand peak: XXXX kW.
 - 3) Electric Power Consumption, by Process Group (kW): XXXX kW.
 - 4) Electric Power Consumption, by Process Group (percent): XX.XX percent (equals Electric Power Consumption, by Process Group (kW)/Sum of Electric Power Consumption on all 480V Meters).
 - 5) Electric Energy Consumption, by Process Group (kW*hr): XXXX kW*hr.
 - 6) Electric Energy Consumption, by Process Group (percent): XX.XX percent (equals Electric Energy Consumption, by Process Group (kW)/Sum of Electric Energy Consumption on all 480V Meters).
 - b. Display a Process Energy Consumption Table that lists the calculated values for each of the identified Groups.
 - c. Display a Process Energy Pie Graph that portions wedges according to the values calculated in Electric Energy Consumption, by Process Group (5). Label wedges, (with numeric percentage), for Groups to cover at least 90 percent of the Pie Graph. The remainder wedge of Pie Graph area can be labelled as "Other" (with numeric percentage).
26. Instruments equipped with digital bus communications:
 - a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below:
 - 1) Instrument diagnostics.
 - 2) Communications health.
 - 3) Process variable.
 - 4) Alarm summary.

- 5) All totalizers (if applicable).
 - 6) Indicate, historize, trend, and alarm data as indicated in the ACS I/O Tables on the Drawings.
27. Calculate, indicate, historize, and trend calculated values for additional, process-specific measurements. Algorithms will be provided by the Engineer.
- a. Influent:
 - 1) Influent flows (diurnally) vs. time (mgd vs. hours for 2 weeks, running).
 - 2) Influent flows (daily vs. time (mgd vs. *day of the week* for 1 week, running).
 - 3) Influent flows (diurnally) vs. time (mgd vs. *month of the year* for the last 3 years, running).
 - b. Aeration basins:
 - 1) BOD loading rate vs. time.
 - 2) MLSS in Aeration Basins vs. time.
 - 3) Solids retention time (total and aerobic) vs. time.
 - 4) Aerobic solids retention time and WW temperature vs. time.
 - 5) Aerobic solids retention time and WAS load vs. time.
 - 6) Aerobic solids retention time and MLSS vs. time.
 - 7) Sludge volume index vs. time.
 - 8) Effluent ammonia and nitrate, phosphorus vs. time.
 - c. Secondary clarifiers:
 - 1) Surface overflow rate vs. time.
 - 2) Solids loading rate vs. time.
 - 3) Effluent TSS vs. time.
 - 4) Solids blanket depth vs. time.
 - 5) RAS flows and percent of influent vs. time.
 - d. Effluent.
 - e. Solids treatment.
 - f. Plant-wide process measurements:
 - 1) Surface overflow rate vs. time.
 - 2) Solids loading rate vs. time.
 - 3) Effluent TSS vs. time.
 - 4) Solids blanket depths vs. time.
 - 5) RAS flows and percent of influent vs. time.
28. Valves and gate operators equipped with digital bus communications:
- a. Communicate and display all controls and data listed in the equipment specification, as indicated on the Drawings, or listed below:
 - 1) Open, close, or direct position commands.
 - 2) Fully open and closed status.
 - 3) Position.
 - 4) High torque, overload and other applicable alarms.
 - 5) Indicate, historize, trend, and alarm data as indicated in the ACS I/O Tables on the Drawings.
 - b. Establish initial torque curves using manufacturer's software for performance tracking and wear.
29. Power failure:
- a. Retain all operating setpoints during power failure.

- b. Restore plant operation to the state it was before the power loss:
 - 1) Store the operating state of all major equipment and systems in the PLC, and retain the last state during a power loss.
- c. Provide an operator selection to permit the plant to re-start. Once re-start is selected:
 - 1) Allow plant loads to re-start, and allow loads to sequence on and ramp up following normal control logic. Where loads were operating in PCS HAND, restore their operation to the state before the power loss.
 - 2) Use the logic described above for preventing concurrent starts to provide necessary delays between each start.
- d. Operating on generator power:
 - 1) Include running and starting kW and kVA requirements for each major equipment and system in registers in the PLC:
 - a) Where running load can vary due to speed, valve position, etc., use the normal starting value plus 25 percent of the difference between the maximum and minimum values.
 - 2) Inhibit starting of loads from process control logic and from operator selection (in PCS HAND) that will exceed generator capability.
 - 3) Generate the following alarms:
 - a) Generator near capacity: When measured kW or kVA reaches 90 percent of the rating of the generator.
 - b) Generator at capacity: When measured kW or kVA reaches 95 percent of the rating of the generator.
 - c) Unable to start: When an operator selects a load that would exceed generator starting or running capacity.
 - d) Insufficient capacity: When the control system needs to start a load, but is inhibited due to generator capacity.
 - 4) Whenever the Generator at Capacity alarm is active, inhibit starting of any loads, and inhibit increase in speed of all control loops, and other changes that would increase electrical load.
 - 5) Display the following power system data on the HMI and LOI in numerical and graphical formats:
 - a) Available power.
 - b) Current power demand.
 - c) Capacity of the generator.
 - d) Current power demand load as a percentage of capacity.
 - e) Generator frequency.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_61_16.10

SPECIFIC CONTROL STRATEGIES - [PROCESS AREA]

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Loop descriptions for Deep Injection System.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Abbreviations:
 - 1. [.]
- C. Definitions:
 - 1. Loop description: Specific control requirements and functional descriptions for individual control loops.
 - 2. [.]
- D. Setpoints:
 - 1. [.]

1.03 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Develop detailed loop descriptions based on the information in the Contract Documents:
 - 1. Submit loop descriptions with implemented modifications from this Section clearly marked.
 - 2. Remove all markings on final loop descriptions submitted with the applicable operation and maintenance manuals.

1.04 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 Sump Pump:

- A. General:
 - 1. References:
 - a. 00N01
 - 2. Key equipment:
 - a. PMP-101, PMP-102 Sump Pumps
 - 3. Abstract:
 - a. Sump Pumping system for each deep injection well will feature automatic pumping feature when a high level is reached in the sump.
- B. Hardwired controls:
 - 1. Pilot devices:
 - a. Field:
 - 1) N/A
 - b. LCP:
 - 1) N/A
 - c. Drive/starter enclosure:
 - 1) Hand – Off – Remote selector Switch
 - d. VCP:
 - 1) N/A
 - 2. Interlocks:
 - a. Drive/starter enclosure:
 - 1) N/A
 - b. VCP:
 - 1) N/A
 - 3. Indicators and alarms:
 - a. Field:
 - 1) N/A
 - b. LCP:
 - 1) N/A
 - c. Drive/starter enclosure:
 - 1) Motor Running Pilot Light indication
 - 2) Motor Fail Pilot Light alarm
 - d. VCP:
 - 1) N/A
- C. PCS controls:
 - 1. Manual mode:
 - a. Operator will have full start/stop control of the pump when the pump is placed in manual mode from the SCADA system.
 - b. Operator can select hand mode from the SCADA Hand-Off-Remote selector switch. When hand mode is selected, the pump can be controlled via the SCADA system manually.
 - c. Operator can select start from the SCADA Start push button to start the pump.

- d. Operator can select stop from the SCADA stop push button to stop the pump.
- e. The field Hand-Off-Remote selector switch for the respective sump pump must be in Remote selection for manual or auto mode operation to be available.
- 2. Auto mode:
 - a. The PLC will control the sump level based upon receiving a high level signal from the sump high level float.
 - b. The PLC will start the sump pump when the high level float signal has been received by the PLC.
 - c. The PLC will stop the sump pump when the level in the sump has fallen below high level float signal for a user-configurable time delay.
 - d. The field Hand-Off-Remote selector switch for the respective sump pump must be in Remote selection for manual or auto mode operation to be available.
- 3. Indicators and alarms:
 - a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
 - b. Additional indicators and alarms:
 - 1) Sump High Level alarm
 - 2) Sump Pump Running
 - 3) Sump Pump Fault
 - 4) Sump Pump in Remote

3.02 DEEP INJECTION FLOW:

- A. General:
 - 1. References:
 - a. 00N01
 - 2. Key equipment:
 - a. EDR-101, EDR-102 Electric Discrete Modulating Valves.
 - b. FE-101, FE-102 Magnetic flow meters.
 - c. PIT-111, PIT-112 Pressure Transmitters.
 - d. LSL-102, LSL-104 Well Annulus Pressure Tanks low level capacitance switch.
 - e. PSH-101, PSL-102, Well Annulus tanks high and low pressure switches
 - 3. Abstract:
 - a. Deep Injection flow control and well annulus tank monitoring
- B. Hardwired controls:
 - 1. Pilot devices:
 - a. Field:
 - 1) N/A
 - b. LCP:
 - 1) Valve actuator Local-Stop-Remote selector switch
 - 2) Valve actuator Open-Stop-Close Selector switch
 - c. Drive/starter enclosure:
 - 1) N/A
 - d. VCP:
 - 1) N/A

2. Interlocks:
 - a. Drive/starter enclosure:
 - 1) N/A
 - b. VCP:
 - 1) N/A
 3. Indicators and alarms:
 - a. Field:
 - 1) N/A
 - b. LCP:
 - 1) Open
 - 2) Closed
 - 3) Position
 - c. Drive/starter enclosure:
 - 1) N/A
 - d. VCP:
 - 1) N/A
- C. PCS controls:
1. Manual mode:
 - a. The Operator will have full control of the DIW control valve. The operator will select a position setpoint (0-100%) for the valve actuator to open.
 - b. The operator will adjust the valve actuator as necessary for the desired flow amount to the DIW.
 - c. The operator will close the DIW valve when the desired flow amount has been delivered to the DIW.
 - d. A totaled value for total and daily total DIW flow values is required.
 2. Indicators and alarms:
 - a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
 - b. Additional indicators and alarms:
 - 1) Valve Actuator in Remote – Indicator
 - 2) Valve Actuator fail – Alarm
 - 3) Valve Actuator Position – Indicator
 - 4) Deep Injection instantaneous flow – Indicator
 - 5) Deep Injection totaled flow – Indicator
 - 6) Deep Injection daily totaled flow (resettable) – Indicator
 - 7) Deep Injection well pressure – indicator
 - 8) Well Annulus tank low level – alarm
 - 9) Well Annulus tank high pressure – alarm
 - 10) Well Annulus tank low pressure - alarm

3.03 MONITORING WELL FLOW

- A. General:
1. References:
 - a. 00N02
 2. Key equipment:
 - a. FE/FIT-103, FE/FIT-104 Magnetic flow meters.
 - b. PIT-103, PIT-104 Pressure Transmitters.
 - c. LSL-103 Monitoring Well sump low level switch.

- d. PMP-04 Sample Pump
 - e. PMP-05 Sample Pump
- 3. Abstract:
 - a. Dual pressure zone monitoring well.
- B. Hardwired controls:
 - 1. Pilot devices:
 - a. Field:
 - 1) N/A
 - b. LCP:
 - 1) Sample Pump Start push button
 - 2) Sample Pump Stop push button
 - c. Drive/starter enclosure:
 - 1) N/A
 - d. VCP:
 - 1) N/A
 - 2. Interlocks:
 - a. Drive/starter enclosure:
 - 1) N/A
 - b. VCP:
 - 1) N/A
 - 3. Indicators and alarms:
 - a. Field:
 - 1) N/A
 - b. LCP:
 - 1) N/A
 - c. Drive/starter enclosure:
 - 1) N/A
 - d. VCP:
 - 1) N/A
- C. PCS controls:
 - 1. Manual Mode:
 - a. Operator will have full start/stop control of the pump when the pump is placed in manual mode from the SCADA system.
 - b. Operator can select hand mode from the SCADA Hand-Off-Remote selector switch. When hand mode is selected, the pump can be controlled via the SCADA system manually.
 - c. Operator can select start from the SCADA Start push button to start the pump.
 - d. Operator can select stop from the SCADA stop push button to stop the pump.
 - e. The field Hand-Off-Remote selector switch for the respective sump pump must be in Remote selection for manual or auto mode operation to be available.
 - 2. Auto mode:
 - a. The PLC will control the sump level based upon receiving a high level signal from the sump high level float.
 - b. The PLC will start the sump pump when the high level float signal has been received by the PLC.

- c. The PLC will stop the sump pump when the level in the sump has fallen below high level float signal for a user-configurable time delay.
 - d. The field Hand-Off-Remote selector switch for the respective sump pump must be in Remote selection for manual or auto mode operation to be available.
3. Indicators and alarms:
- a. Refer to Drawings and Section 40_61_15 - Control Strategies for indicators and alarms.
 - b. Additional indicators and alarms:
 - 1) PE/PIT-103, Monitoring well level - Indicator
 - 2) PE/PIT-104, Monitoring well level - Indicator
 - 3) FE/FIT-103, Monitoring well flow - Indicator
 - 4) FE/FIT-104, Monitoring well flow - Indicator
 - 5) LSH-103, Sump Pump High Level – Alarm
 - 6) AUX1-05 Sump Pump Running
 - 7) AUX2-05 Sump Pump Fault
 - 8) HSAR-05 Sump Pump in Remote

3.04 TESTING

- A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

END OF SECTION

SECTION 40_64_01

CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Programmable logic controller (PLC) based control systems hardware.
 - 2. Development software to be used with the specified PLC hardware.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Institute of Electrical and Electronics Engineers (IEEE).

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. CPU: Central processing unit.
 - 2. I/O: Input/Output.
- C. Specific definitions:
 - 1. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.
 - 2. Application software: The software that is programmed specifically for the Project.

1.04 SYSTEM DESCRIPTION

- A. Provide all PLC hardware as indicated on the Drawings and as specified in this Section.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01_33_00 - Submittal Procedures and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
 - 1. CPU: Allen Bradley Compact Logix: 1769-L33ER, no exceptions.
 - a. Processor type. 1769-L33ER
 - b. Processor speed.

- c. Memory. Minimum, 2MB
 - d. Internal processor battery backup time.
- 2. I/O modules:
 - a. Type.
 - b. Standard wiring diagram.
- C. Calculations:
 - 1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.
 - 2. Submit calculations to verify that spare I/O requirements of this Section are met.
 - 3. Submit calculations to verify that PLC power supply requirements of this Section are met.
- D. Product data:
 - 1. Programming languages.
 - 2. Operating system requirements.
- E. Control logic:
 - 1. Fully annotated copy of programmed PLC logic.
 - 2. Cross-referenced index of all PLC registers or points.
- F. Provide application software for the specific Project process requirements.
 - 1. Fully annotated copy of programmed PLC logic in its native format.
 - 2. Cross-referenced index of all PLC registers or points.

1.06 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.
- C. Additional requirements:
 - 1. Provide PLC system components by a single manufacturer:
 - a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
 - 2. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
 - 3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. In addition to the spare parts requirements specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems, furnish the following:
 - 1. CPU: 1 spare for each type of CPU in the system.
 - 2. I/O cards: 3 spares for each type of I/O card in the system.
 - 3. Power supplies: 2 spares for every power supply in the system.
 - 4. Network/communications cards: 1 spare for every network or communications card in the system.
 - 5. Remote adapter: 1 spare for every remote adaptor in the system.
 - 6. Chassis: 1 spare for each chassis size in the system.
 - 7. Communication cable: 1 spare for each type of cable used in the system.
- C. Installed spare requirements:
 - 1. I/O points:
 - a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC and remote inputs and outputs (RIO).
 - b. Wire all spare I/O points to field terminal blocks in the same enclosure the PLC resides in.
 - 2. PLC backplane capacity:
 - a. Provide 25-percent or 3 spare backplane slots, whichever is greater, in all racks containing I/O.
 - 3. PLC memory:
 - a. Provide 50-percent spare program volatile memory.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Only the following no equal:
 - 1. Rockwell Automation:
 - a. CompactLogix 1769-L33ER
- B. The PLC programming software system shall be manufactured by PLC hardware manufacturer:
 - 1. Rockwell Software:
 - a. Studio 5000 version 32

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. Programmable logic controller:
 - 1. Construction:
 - a. Furnish plug-in modular system.
 - b. Provide PLCs capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:
 - 1) Temperature: 0 to 55 degrees Celsius.
 - 2) RFI: 80 to 1,000 MHz.
 - 3) Vibration: 10 to 500 hertz.
 - 4) Humidity: 0 to 95 percent.
 - c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.
 - d. Design the PLC system to function as a standalone unit that performs all of the control functions described in this Section completely independent from the functions of the HMI system PC-based operator interfaces:
 - 1) Failure of the HMI system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
 - 2. CPU:
 - a. Configure each CPU so that it contains all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.
 - b. Capable of interfacing with all discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.
 - c. Capable of supporting and implementing closed-loop floating-point math and PID control that is directly integrated into the CPU control program.
 - 3. Memory:
 - a. Non-volatile memory: On-board complementary metal-oxide-semiconductor (CMOS), electrically erasable programmable read-only memory (EEPROM), PCMCIA, compact flash card, or SD card.

- b. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:
 - 1) Reserve capacity:
 - a) Totally free from any system use.
 - 2) Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.
- 4. Programming:
 - a. Provide a system where processors are programmed by:
 - 1) Portable laptop computer both locally and via the PLC control network.
- 5. PLC power supply:
 - a. Input: 120 VAC.
 - b. Mounted in the PLC housing or as indicated on the Drawings.
 - c. Sized to power all modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.
- 6. PLC input/output, I/O modules: 8-channel, 16-channel and/or 32-channel:
 - a. General:
 - 1) Compatible with all of the PLCs being furnished under the contract and by the same manufacturer as the PLCs.
 - 2) Provide I/O modules that:
 - a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
 - b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
 - c) Accept dual-ended inputs.
 - 3) The use of common grounds between I/O points is not acceptable.
 - 4) Provide modules that are removable without having to disconnect wiring terminals:
 - a) Utilize a swing-arm or plug-in wiring connector.
 - 5) Provide at each PLC the I/O modules for the following:
 - a) Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
 - b) Installed spare capacity in accordance with the requirements of this Section.
 - c) Wire all spares provided to the field terminal strip.
 - 6) Condition, filter, and check input signals for instrument limit conditions.
 - 7) Filter, scale, and linearize the raw signal into an engineering-units-based measurement.
 - 8) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
 - 9) Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.
 - 10) When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.

- b. Discrete input modules:
 - 1) Defined as contact closure inputs from devices external to the input module.
 - 2) Provide inputs that are optically isolated from low-energy common-mode transients to 1,500 volts peak from users wiring or other I/O modules.
 - 3) Individually isolated inputs.
 - 4) With LEDs to indicate status of each discrete input.
 - 1) Input voltage: 24VDC.
 - 5) Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:
 - a) Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.
- c. Discrete output modules:
 - 1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
 - a) Triac outputs may be used, with the permission of the Engineer. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
 - 2) Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.
 - 3) LEDs to indicate status of each output point.
 - 4) Output voltage 24VDC.
 - 5) Individually isolated outputs.
- d. Analog input modules: individually isolated
 - 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
 - 3) The analog-to-digital conversion updated with each scan of the processor.
 - 4) Individually isolated each input.
 - 5) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.
 - 6) Provide field mounted surge suppression modules for all analog signals that are located outside the building that houses the PLC node.
 - a) Manufacturers: One of the following or equal:
 - (1) Emerson/Edco, model SS65-036-2, or similar for loop powered field instruments.
 - (2) Emerson, model 265 (SLAC) series.
 - (3) Phoenix Contact, PLUGTRAB SEC series, or similar for field instruments that require auxiliary power (24VDC/VAC, 120VAC, 230VAC).

- e. Analog output modules:
 - 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Differential analog inputs only, single ended analog inputs are not allowed.
 - 3) Analog input modules to be provided with HART Interface.
 - 4) Individual isolated output points each rated for loads of up to 1,000 ohms.
 - a)
 - 5) HART analog input module:
 - a) Channels per module: 4 minimum.
 - b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
 - c) Each channel can individually have HART enabled or disabled.
 - d) Flash-upgradeable firmware.
 - e) Mounts in slot in PLC backplane.
 - f) Modules shall be configured using the specified PLC programming software.
- 7. Communications modules:
 - a. Network communications modules:
 - 1) General:
 - a) Install communications modules in the PLC backplane
 - 2) Ethernet:
 - a) Ports: 2,RJ-45,Fiber optic.
 - b) Communication rate: 100 Mbit/s, minimum
 - 3) Modbus:
 - a) Ports: 1.
 - b) Each port individually configurable as Modbus Client or Server.
 - 4) Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.
- 8. PLC backplane housing:
 - a. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.
 - b. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.
 - c. Provide a blank slot filler module for each spare slot.
- B. HMI system interface:
 - 1. As specified in Section 40_66_01 - Control Systems: Network Materials and Equipment.
- C. PLC programming software:
 - 1. Furnish operating software capable of monitoring and/or controlling the PLCs via the PLC data network:
 - a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.

- b. Monitor devices at each drop on the PLC data network for proper communications.
 - c. Provide the ability to program all PLCs on the PLC data network from the Engineer's console.
- 2. PLC programming laptop/desktop operating system:
 - a. Microsoft Windows 10.
- 3. The PLC programming software shall be suitable for the PLCs specified above.
- 4. PLC programming software for all programming, monitoring, searching, and editing:
 - a. Usable both on-line, while connected to the PLC, and off-line.
 - b. The operating software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.
 - c. Capable of disabling/forcing all inputs, outputs, and coils to simulate the elements of the ladder logic; forced elements shall be identifiable by means of color change.
 - d. Include a search capability to locate any address or element and its program location.
 - e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.
- 5. The PLC programming software shall support the following programming languages:
 - a. Ladder Diagram.
- 6. Generate a PLC program printout, which is fully documented, through the PLC programming software:
 - a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.
 - b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.
 - c. Use a mnemonic associated with each contact, coil, etc. that describes its function.
 - d. Utilize the tag and loop identification as contained in the P&IDs:
 - 1) If additional internal coils, timers, etc. are used for a loop, they shall contain the loop number.
 - e. Provide a cross-reference report of program addresses.
- 7. Software functions automatically without operator intervention, except as required to establish file names and similar information:
 - a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:
 - 1) Respond to demands from a program request.
 - 2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
 - 3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.
 - 4) Queuing of requests in order of priority if one or more requested resources are unavailable.

- 5) Resolution of contending requests for the same resource in accordance with priority.
- 6) Service requests for execution of one program by another.
- 7) Transfer data between programs as requested.
- 8) Management of all information transfers to and from peripheral devices.
- 9) Control and recovery from all program fault conditions.
- 10) Diagnose and report real-time hardware device errors.
8. Program execution:
 - a. Application software - program execution scheduled on a priority basis:
 - 1) A multilevel priority interrupt structure is required.
 - 2) Enter into a list of pending programs a program interrupted by a higher priority program:
 - a) Resume its execution once it becomes the currently highest priority program.
 - 3) Schedule periodic programs.
 - 4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.
9. Start-up and restart:
 - a. Provide software that initializes and brings a PLC or any microprocessor-based hardware unit from an inactive condition to a state of operational readiness.
 - b. Initialization:
 - 1) Determination of system status before start-up of initializing operating system software and initializing application software.
 - 2) Loading of all memory-resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.
10. Shutdown:
 - a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.
 - b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
 - c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
 - d. Alarm PLC failure at the operator interface level.
11. Diagnostics:
 - a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
 - b. Use the manufacturer's standard diagnostic routines as much as possible.
 - c. Furnish diagnostic software and test programs for each significant component in the control system.
 - d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.
12. Calendar/time program:
 - a. The calendar/time program to update the second, minute, hour, day, month, and year and transfer accurate time and date information to all system-level and application software.

- b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
 - c. The operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
- 13. Algorithms:
 - a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
 - b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
 - c. Algorithms must include alarm checks where appropriate.
 - d. Provide, as a minimum, the following types of algorithms:
 - 1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
 - 2) A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.
 - 3) A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supports both direct and reverse-acting modes.
 - 4) Lead, lag, dead time, and ratio compensators.
 - 5) Integration and totalization of analog process variables.
- 14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
 - a. In addition, provide spare database points for future expansion.
- 15. One integrated database can be utilized for all types of analog points or separate databases for each type; in either case, the database for each point must include all specified aspects.
- 16. All portions of the database must be available for use by the display, report, and other specified software modules.
- 17. All of the data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all of the features and functions defined below. The analog database software must support the following functions and attributes:
 - a. Analog input signal types:
 - 1) Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
 - b. Input accuracy:
 - 1) Inputs must be read with an accuracy of within 0.05-percent full-scale or better.
 - 2) Data conversion errors must be less than 0.05-percent full-scale.
 - 3) Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once per minute.
 - 4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.

- c. Blocking:
 - 1) Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.
 - 2) For any input so blocked, the operator may manually enter a value to be used as the input value.
- d. Filtering:
 - 1) For each analog input, provide a first order lag digital filter with an adjustable filter factor.
- e. Linearizing:
 - 1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.
- f. Calculated values:
 - 1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated values, constants, etc.
 - 2) These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.
- g. Scaling and zero suppression:
 - 1) Provide a conversion program to convert input values into engineering units in a floating-point format.
- h. Alarms:
 - 1) Provide an alarm program to check all analog variables against high-high, high, low, and low-low alarm limits.
 - 2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.
 - 3) Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.
 - 4) Must be possible to inhibit alarms based on external events, e.g., lock-out low pump flow alarm when the pump is off.
- i. Averages:
 - 1) Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.
 - 2) Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.
 - 3) Update hourly averages each minute or at the polling interval for the selected variable.
 - 4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
 - 5) Update monthly averages at least once each day and calculate using the results of the daily averages.
 - 6) At the end of each averaging period, store the average values for the period on the hard disk for historical record-keeping and reset the present period average register to the present value of the variable.
 - 7) The active database must include the present period average and previous period average for each variable and averaging period.
- j. Totals:
 - 1) Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.

- 2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
 - 3) Assign a separate factor for each totalizing interval.
 - 4) Variables for which totalization is inappropriate must have scaling factors of zero.
 - 5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record-keeping and reset the present period totalization register to zero.
 - 6) The active database must include the present period total and previous period total for each variable and totalizing period.
- k. Engineering units:
- 1) Provide software to allow the system and the operator to convert all the measured analog variables to any desired engineering units.
 - 2) The operator must be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in gpm, mgd, cfs, and acre-feet per day.
 - 3) Pre-program the conversion of the engineering units, and, if not pre-programmed, the operator must be able to program new engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.
 - 4) The programming method must be at a level and compatible with the specified training of the operator and the Owner's personnel.
 - 5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.
- l. Control modules:
- 1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
 - 2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.
 - 3) Provide control algorithms for manual control with output values adjustable by the operator.
- m. Analog outputs:
- 1) Analog outputs must be maintained as part of the database.
 - 2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.
18. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.
- D. General control functions:
1. Analog control functions:
 - a. PID, lead/lag, signal select, alarm, limit, delay, and time base.
 - b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.

- c. All math utilities must be linkable to process data points or manual inputs via control block configuration.
 - d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.
 - 2. Discrete control functions:
 - a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.
 - 3. Software support:
 - a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.
 - b. Call each function as required by the configured controls to perform the intended function.
 - 4. Control and status discrepancies:
 - a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.
 - 1) For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator-programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.
 - b. Involuntary change in the device's status must also generate an alarm:
 - 1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
 - c. Each command, status, and alarm must cause the color of the symbol to change.
 - d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:
 - 1) Delay periods for each final control element must be adjustable at the operator interface.
 - 2) List all time delays in the final documentation.
 - 5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.
- E. Control configuration:
- 1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.
 - 2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, setpoints, tuning constants, etc.
 - 3. Provide a mechanism to link separate control functions together into an integrated control strategy.
 - 4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.

5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU, and to upload them to the operator interface for operational record-keeping.
 6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.
- F. Remote inputs and outputs (RIOs):
1. Compatible with all of the PLCs being furnished under this Contract, shall be by the same manufacturer as the PLCs, and, as a minimum, include:
 - a. Power supply.
 - b. Rack.
 - c. Backplane.
 - d. Communications module.
 - e. I/O modules.
 - f. Enclosure.
 2. Provide all cables and software needed for a complete and operational RIO system as specified in the Contract Documents.
 3. Provide a group of pre-assigned diagnostic registers to report RIO system faults to the driver PLC.
 4. The control system must continue operation should a fault occur on a single RIO drop:
 - a. Upon clearing the fault, restart communications to that drop automatically.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

- B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
 - 1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.
- C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.
- D. General:
 - 1. The control system logic program shall reside at the PLC level.
- E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.
- F. Program the PLC logic using the following language(s):
 - 1. Ladder Diagram.
 - 2. Function Block Diagram.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

- A. Provide a minimum of 4 CD/DVD copies of the following:
 - 1. Application software:
 - a. Finalized fully annotated copy of programmed PLC logic in its native format.
 - b. Cross-referenced index of all PLC registers or points.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.10 DEMONSTRATION AND TRAINING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Tailor training specifically for this Project that reflects the entire control system installation and configuration.

- C. Perform training by pre-approved and qualified representatives of the ICSC and/or manufacturer of the PLC hardware and programming software:
 - 1. A representative of the ICSC may perform the PLC hardware training only if the representative has completed the manufacturer's training course for the PLC hardware.
 - 2. A representative of the ICSC may perform the PLC programming software training only if the representative has completed the manufacturer's training course for the PLC programming software.

3.11 PROTECTION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_66_01

CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Materials and equipment used in process control and LAN networks including:
 - a. Network switches.
 - b. Media converters.
 - c. Patch panels and other data network hardware.
 - d. Related accessories.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Electronic Industries Alliance/Electronic Components, Assemblies & Materials Association (EIA/ECA):
 - 1. 310-E - Cabinets, Racks, Panels, and Associated Equipment.
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 802.1X - Standard for Local and Metropolitan Area Networks—Port-Based Network Access Control.
 - 2. 802.3 - Standard for Ethernet.
 - 3. 802.11b - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher Speed Physical Layer (PHY) Extension in the 2.4 GHz band.
- D. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
- E. Telecommunications Industry Association (TIA):
 - 1. 569 - Telecommunications Pathways and Spaces.
 - 2. 607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- F. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

- A. Furnish submittals as specified in Sections 01_33_00 - Submittal Procedures and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
 - 1. Include information on all network equipment.
 - 2. Manufacturer's operation and installation instructions.
- C. Shop drawings:
 - 1. Complete set of drawings including but not limited to:
 - a. System block diagram showing relationship and connections between devices provided under this Contract, including connections to any existing equipment.
 - b. Include manufacturer and model information, and address settings.
 - c. Network riser diagram.
 - d. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
 - e. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
 - f. Electrical connection diagrams.
 - g. Complete grounding requirements.
 - 2. Furnish data sheets for each component together with a technical product brochure or bulletin:
 - a. Manufacturer's model number.
 - b. Project equipment tag.
 - 3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
 - a. Quantity.
 - b. Description.
 - c. Manufacturer.
 - d. Part numbers.
- D. Calculations:
 - 1. Cooling calculations, including but not limited to:
 - a. Highest expected ambient temperature for the enclosure's location.
 - b. Internal heat load.
 - c. Exposure to direct sunlight.
 - d. Dimensions of the enclosure in inches.
 - e. Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.
- E. Test reports:
 - 1. As specified in Section 26_05_05 - Conductors and Section 40_80_01 - Commissioning for Instrumentation and Controls.
 - 2. Signed test results as described in this Section.
 - 3. Test results shall include:
 - a. Narrative describing the test procedures followed.
 - b. Block diagram of test set up.

- c. Manufacturer's information on test equipment used.
 - d. Detailed test results.
 - e. A narrative summarizing the results of the testing and identifying any further action required.
- F. Operating manuals:
 - 1. Complete installation, operation, calibration, and testing manuals as specified in Section 01_75_17 - Commissioning.
- G. Record drawings:
 - 1. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.
 - 2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.05 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 SEQUENCING (NOT USED)

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

1.11 SYSTEM START-UP (NOT USED)

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 COMMISSIONING (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 SYSTEM DESCRIPTION

A. Provide all network equipment identified in the Contract Documents.

2.03 EXISTING PRODUCTS (NOT USED)

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS

A. Ethernet switches:

1. Managed Process Floor Ethernet switches:
 - a. Manufacturers: One of the following, no equal:
 - 1) Rockwell, Stratix 5800 Series.
 - b. Properties:
 - 1) Hardware:
 - a) Power supply:
 - (1) Accepts redundant power feeds.
 - (a) Provide NEC Class 2 power circuit.
 - (b) 24 VDC, 100VA maximum rating.
 - b) No fans or moving parts.
 - 2) Performance:
 - a) Enclosure:
 - (1) All metal housing.
 - b) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
 - (1) SNMP.
 - (2) VLANs.
 - (3) QoS.
 - (4) Port Mirroring.
 - (5) DHCP Server
 - c) IGMP Snooping with EtherNet/IP plug & play compatibility.
 - d) 802.1d, 802.1w, 802.1D RSTP.
 - e) Resilient Ethernet Protocol (REP).
 - f) Port mirroring/Switch Port Analyzer (SPAN).
 - g) Port security (MAC ID-based).
 - h) Port thresholds.
 - i) Precision Time Protocol (PTP).
 - j) Smartports.
 - k) VLAN Trunk Protocol (VTP).
 - l) Network Time Protocol (NTP).
 - 3) Environment:
 - a) Operating temperature range: 32 to 140 Degrees Fahrenheit.
 - b) Humidity: 10 to 95 percent, non-condensing.
 - 4) Connections:
 - a) Copper: RJ-45.
 - (1) Auto-negotiating.
 - (2) Quantity: As required to provide network connections indicated on the Drawings plus 20 percent spare.

- b) Fiber: Gigabit SFP port.
 - (1) Quantity: As required to provide network connections indicated on the Drawings, minimum 2.
 - 5) Mounting:
 - a) DIN Rail mounting.
- B. SFP Transceivers:
 - 1. Provide, quantity of one each for each open SFP port on the switch, Gigabit transceivers unless otherwise indicated:
 - a. Single-mode: 1000BASE-LX10 minimum
 - b. Multimode: 1000BASE-SX minimum
 - c. Multi-source agreement compliant.
 - 2. Manufacturers: The following, no equal:
 - a. Allen Bradley
- C. Patch panels:
 - 1. Fiber optic patch panels:
 - a. General:
 - 1) All optical fiber cables shall be provided with strain relief and terminated at a fiber patch panel. Final connections between the patch panel and the fiber optic network equipment shall be made via factory tested fiber optic patch cords.
 - 2) All fiber cable strands shall be terminated at the patch panels, no loose fiber strands are allowed.
 - 3) Provide space for excess fiber and provide strain relief for the fiber cable.
 - 4) Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
 - 5) Fiber connectors: LC.
 - b. 19-inch rack mounted:
 - 1) Manufacturers: One of the following or equal:
 - a) Corning.
 - b) Panduit.
 - c) Optical Cable Corporation (OCC).
 - 2) Properties:
 - a) Housing:
 - (1) Use for combination of splicing and termination of fiber-optic building cable or outside plant cables.
 - (2) Up to 4U rack units in height.
 - (3) Fully enclosed.
 - (4) Interconnect and cross-connect capability.
 - (5) Modules shall be interchangeable.
 - (6) Compatible with connector panels, modules, and cassettes.
 - 3) Accessories:
 - a) Hinged front doors.
 - b) Front cable management trough.
 - c) Top cover panel.
 - d) Configurable internal strain relief.

- e) Blanks for unused connector panels.
 - f) Splice tray.
 - c. DIN Rail mounted:
 - 1) Manufacturers: One of the following or equal:
 - a) DINSpace, SNAP XL.
 - b) Corning.
 - c) Hirschmann, MIPP.
 - 2) Properties:
 - a) Use for the termination of a single cable inside of cabinets, in small enclosures or as indicated on the plans.
 - b) DIN rail mounted fiber patch panels shall be provided as complete unit including the housing, connector panels, splice trays, and fiber connectors.
 - d. Wall mounted:
 - 1) Manufacturers: One of the following or equal:
 - a) Corning.
 - b) Optical Cable Corporation (OCC).
 - 2) Properties:
 - a) Use for the termination of a single cable outside of cabinets, in small enclosures or as indicated on the plans.
 - b) Wall mounted fiber patch panels shall be provided as a complete unit including the housing, connector panels, splice trays, and the fiber connectors.
 - c) Physical protection for all incoming and outgoing cables and patch cords.
 - 3) Accessories:
 - a) Door lock.
 - b) Blanks for unused connector panels.
- D. Copper patch panels:
 - 1. General:
 - a. All equipment and premises cables shall be terminated at a patch panel, except for field equipment connections.
 - b. Final connections between the patch panel and network equipment shall be by patch cords.
 - c. Provide factory tested copper patch cords as required to support all network devices.
 - 1) Provide 25 percent spare copper patch cords.
 - d. Cables shall be installed such that the outer sheath of the cable is carried into the patch panel before breaking out conductors.
 - e. Maintain twist of broken out conductors in accordance with TIA standards.
 - f. UL listed.
 - g. Properties:
 - 1) Modular, all metal construction with built-in strain relief.
 - 2) Compatible with both shielded and unshielded jack modules.
 - 3) Patch panel and jack modules shall be by same manufacturer.
 - 4) Utilizes jack modules for copper Ethernet cable termination.
 - 5) Provided shielded jack modules with a 360-degree conductive path to ground as required by the installation. Install per manufacturer's recommendation.

- 6) Patch panel and jack modules shall meet or exceed category cable standard.
- 7) Jack module shall be capable of at least 20 termination cycles.
- 8) Provide 25 percent spare jack modules of each type.
- h. Accessories:
 - 1) Removable rear cable management bracket.
 - 2) Rear individual port labels.
 - 3) Front color-coded individual port labels.
 - 4) Termination tool.
- 2. Manufacturers: One of the following or equal:
 - a. 19-inch rack mounted:
 - 1) Panduit, Mini-Com series.
 - 2) OCC, DCC series.
 - 3) CommScope, SL series.
 - b. DIN Rail mounted:
 - 1) DINSpace, SNAP XL.
 - 2) OCC, DTC.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS (NOT USED)

2.08 ACCESSORIES

- A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.
- B. Provide dust covers or plugs for all unused ports.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide installation and configuration for the new and existing managed Ethernet switches. Provide configuration of the Ethernet switch network for a complete,

functioning plant control system as indicated on the Drawings and as specified in this Section:

1. Refer to SCADA block diagrams for all new network connections.
2. Provide configuration for all managed Ethernet switches and other components including but not limited to VLAN (virtual local area network), additional Plant PLC communication cards, and separate managed Ethernet switches as required, such that there is isolation of the following networks:
 - a. Remote I/O network: This includes the connections between the Plant PLC and:
 - 1) Plant PLC expansion racks.
 - 2) Plant PLC remote I/O (RIO) racks.
 - b. Field network: This includes the connections between the PLC and:
 - 1) Field devices.
 - 2) LOI (Local Operator Interface).
 - 3) Vendor furnished Ethernet network components.
 - 4) Valve actuator network: This includes the connections between the PLC and the valve master stations.
 - c. PLC network: This includes the connections between the Plant PLCs and the I/O server(s).
 - d. Process control network: This includes the connections between the I/O server(s) and other equipment including but not limited to servers, workstations, and printers.
 - e. Security control network: This includes any security hardware with Ethernet communication as provided by the security subcontractor.
3. The process floor managed Ethernet switches for the process control network shall be configured and programmed for rapid fail over protection.
4. The enterprise level managed Ethernet switches shall be configured for a communication protocol that is compatible with the process control network's rapid fail over protocol.

C. All racks shall be level and plumb.

D. All work shall be performed in a neat and workmanlike manner.

E. Cable management:

1. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations:
2. Install cable using lubricant designed for cable pulling.
3. Install hook-and-loop wrap on all cable bundles within the network rack/enclosure. Plastic tie-wraps are not acceptable.
4. Install network cables without splices.
5. Installed bend radius shall be a minimum of 10 times the cable diameter.
6. Terminate all pairs at the jack and patch panel.
7. Route all cables through cable management or other form of containment. No loose, unsupported cables are permitted to span across network equipment.
8. Use corner strips to protect cables from edges inside ducts and to maintain bend radius requirements.

F. Internal rack wiring:

1. Cables shall be installed avoiding sharp bends.

2. Provide enough working space inside rack or cabinets such that closing enclosure doors does not crush or compress cabling.
 3. Bundle cables together in groups of no more than 12.
 4. Route cables from both sides of the rack to patch panels. Do not bring all bundles from a single side.
 5. No cabling shall obstruct equipment ventilation.
 6. Individual pairs will be untwisted less than 1/2-inch at termination points.
 7. Ground enclosure and equipment in accordance with TIA-607.
 - a. Individually bond all network equipment chassis to rack's grounding busbar. Do not daisy-chain bonding conductors.
 - b. Size the bonding conductor per network equipment manufacturer's recommendation, or #10 AWG, whichever is larger.
- G. External rack wiring:
1. Do not install fiber cables in non-continuous cable supports such as cable ladders or wire baskets without radius cable supports or solid bottoms.
 2. Maintain cable separation in accordance with TIA-569.
 - a. Install cables a minimum of 40 inches away from electrical motors and transformers.
 - b. Install cables a minimum of 12 inches away from fluorescent lighting.
- H. All cables and terminations shall be labeled with cable designations as specified in Section 26_05_05 - Conductors.
- I. Each data port shall be individually labeled with its patch panel/switch port ID:
1. Labeling must be printed - no handwritten labels will be allowed.
- J. At the completion of the wiring installation, provide the following documentation:
1. A plan-view of the premise(s) showing the jack numbering scheme.
 2. A printed certification report for the entire wiring installation showing compliance with all TIA specifications for data cable.
 3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.
- K. Managed Ethernet switches:
1. Configure switches to prevent broadcast storms.
 2. All installations shall employ IGMP snooping to limit multicast messaging.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING

- A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

3.09 CLEANING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.10 DEMONSTRATION AND TRAINING

- A. After completion of the cable system tests and before placing the system in operation, power up all devices installed on the LAN and verify communication between the devices.
- B. Verify that all equipment is operable on the network simultaneously. Confirm that all network device communications settings are properly configured.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_67_01

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

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PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
 - a. Custom built instrumentation and control panels, including all enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
 - b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs) and chemical feed panels.
 - c. Control components.
 - d. Control panel installation.
- B. Provide all control panels identified in Contract Documents.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
 - 2. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
 - 3. 802.3at - Standard for Information Technology -- Local and Metropolitan area networks -- Specific requirements -- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements.
- C. International Electrotechnical Commission (IEC):
 - 1. 61643-11 - Low-Voltage Surge Protective Devices - Part 11: Surge Protective Devices Connected to Low-Voltage Power Systems - Requirements and test methods.
 - 2. 61643-21 - Low-Voltage Surge Protective Devices - Part 21: Surge Protective Devices Connected to Telecommunications and Signaling Networks - Performance Requirements and Testing Methods.
- D. Underwriters Laboratories Inc. (UL):
 - 1. 248-14 - Low-Voltage Fuses - Part 14: Supplemental Fuses.
 - 2. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
 - 3. 508 - Standard for Industrial Control Equipment.
 - 4. 508A - Standard for Industrial Control Panel.

5. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
6. 913 - Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.
7. 1077 - Standard for Supplementary Protectors for Use in Electrical Equipment.
8. 1283 - Standard for Electromagnetic Interference Filters.
9. 1449 - Standard for Surge Protective Devices.

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 1. The term "panel" in this Section is interchangeable with the term "enclosure."

1.04 SUBMITTALS

- A. Provide submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide a control panel hardware submittal for each control panel/enclosure being provided on this project, including but not limited to:
 1. Product data:
 - a. Enclosure construction details and NEMA type.
 - b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
 2. Shop drawings:
 - a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
 - 1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
 - b. Complete nameplate engraving schedule.
 - c. Structural details of fabricated panels.
 3. Calculations:
 - a. Provide installation details based on calculated shear and tension forces:
 - 1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
 - b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
 - 1) Weight including panel internal components.
 - 2) overturning moments.
 - 3) Shear and tension forces in connections.
 - c. Cooling calculations, including but not limited to:
 - 1) Highest expected ambient temperature for the enclosure's location.
 - 2) Internal heat load.
 - 3) Exposure to direct sunlight.
 - 4) Dimensions of the enclosure in inches.
 - 5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

1.05 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
 - 1. Provide all components and equipment with UL 508 listing.
 - 2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling:
 - a. Non-listed, complex, and unique equipment may be evaluated and approved by a third-party testing agency, with prior approval by the Owner. Provide report documenting the testing standard, specification, method of testing, and that the equipment and materials meet appropriate designated standards or have been tested and found suitable for use in a specified manner.
 - 3. Provide fuses for all equipment that is not UL or UR listed.
 - 4. Install all intrinsically safe circuits and equipment in accordance with UL698A.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Project environmental conditions as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
 - 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, humidity, and process and ambient temperatures.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation.

1.08 SEQUENCING (NOT USED)

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.11 SYSTEM START-UP (NOT USED)

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 COMMISSIONING (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. As listed below in the individual component paragraphs.
- B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.02 SYSTEM DESCRIPTION

- A. Panel dimensions:
 - 1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or manufacturer to design and size all panels:
 - a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
 - b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes indicated on the Drawings must be approved by the Engineer.
 - c. Maximum panel depth: 32 inches, unless otherwise indicated.

2.03 EXISTING PRODUCTS

- A. Provide labor and materials for complete modifications to existing panels as required.
- B. Field cut and refinish existing panel faces to original condition to accommodate installation of new instruments, removal of existing instruments, and fitting of blanks to suit new layouts. New instrument supports shall be provided as required for complete installation.

2.04 MATERIALS

- A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
 - 1. Enclosures shall have the following properties:
 - a. NEMA Type 1: Steel.
 - b. NEMA Type 4: Steel with gasketed door, raintight.
 - c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is indicated on the Drawings).
 - d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.
 - e. NEMA Type 12: Steel with gasketed door, dusttight.
 - f. NEMA Type 7: Cast aluminum.
- B. Bolting material:
 - 1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.

2. Carriage bolts for attaching end plates.
3. All other bolted joints shall have S.A.E. standard lock washers.

2.05 MANUFACTURED UNITS

A. Panels/enclosures:

1. Manufacturers: One of the following or equal:
 - a. nVent/Hoffman.
 - b. Saginaw Control & Engineering.
 - c. Rittal.
2. Panel assembly:
 - a. General guidelines for panel fabrication include:
 - 1) Continuous welds ground smooth.
 - 2) Exposed surfaces free of burrs and sharp edges.
 - 3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.
 - b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	14	14
Up to 57	12	12
57 - 69	12	10
69 - 82	12, except 10 on back	10
82 or more	10	10

- c. For Rittal or engineer approved equal free-standing modular enclosure, construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	16	14
Up to 57	14	13
57 or more	16	11

- d. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.

- e. Provide stiffeners for back mounting or C folded back panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.
- f. Door construction:
 - 1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
 - 2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
 - 3) Heavy-gauge stainless steel hinges.
 - 4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
 - 5) Gasket installed to seal against roll lip on the enclosure opening.
- g. Latches:
 - 1) For panels, provide each door with an oil tight 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
 - a) Provide padlock for each enclosure with padlock provisions.
 - b) Provide 2 keys per panel.
 - c) All locks keyed alike.
 - 2) For Rittal or engineer approved equal free-standing modular enclosure, provide each door with a 4-point latching mechanism, if available, or a 2-point latching mechanism if a 4-point is not available.
 - 3) For cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.
- h. Panel cut-outs:
 - 1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
 - 2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.
 - 3) Reinforce around cut-outs with steel angles or flat bars for the following:
 - a) Large panel cutouts; for example, openings for local operator interfaces.
 - b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.
- 3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
 - a. Minimum 16-gauge, Type 304 stainless steel.
 - b. Captive stainless steel cover screws threaded into sealed wells.
 - c. Inside finish: White polyester powder coating.
 - d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.
 - e. NEMA Type 4X powder-coated stainless steel enclosures are not an acceptable substitute for stainless steel unless indicated on the Drawings.
- 4. In addition to the requirements specified above, the following requirements apply for NEMA Type 4X non-metallic enclosures:
 - a. Fiberglass construction.

- b. 10-gauge plate-steel reinforcing on the sides, top, and bottom.
 - c. All seams sealed.
 - d. Fiberglass hinges with no exposed metal parts.
 - e. Captivate stainless steel door screws.
 - f. Provisions for internal, sidewall mounting panels either by welded channels to the interior, or by welded collar studs.
 - g. Provide aluminum mounting panels.
 - h. Non-metallic enclosures are not an acceptable substitute for stainless steel unless indicated on the Drawings.
- 5. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
 - a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
 - b. Door hardware: Stainless steel.
 - c. Provide factory installed rain canopy and sun shield for all enclosures with operator interface panels.
 - d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.
 - e. Fabricated with 316 stainless steel, powder coated white.
 - f. 316 Stainless steel sunshields on top, sides, and front, powder coated white.
 - g. Must be Watershed (sloped top) style enclosure.
- B. Arrangement of components:
 - 1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
 - 2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.
 - 3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
 - 4. All control panel mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.
- C. Overcurrent protection:
 - 1. Main overcurrent device:
 - a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
 - 1) Door-mounted disconnect handles are not acceptable.
 - 2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
 - 3) Provide means to defeat the interlock.
 - 4) Lockable in the off position.
 - b. Control panels supplied with 120 VAC:
 - 1) Provide an internal breaker with the line side terminals covered by a barrier.

- 2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
- 3) Provide a nameplate prominently positioned on the control panel stating "CAUTION Risk of Electric Shock – UPS equipment outputs remain energized with main disconnect in off position" for any panel containing a UPS.
2. Provide circuit breakers
3. Selection and ratings of protective devices:
 - a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
 - b. Voltage rating: Not less than the voltage of the application.
 - c. Select current rating and trip characteristics to be suitable for:
 - 1) Maximum normal operating current.
 - 2) Inrush characteristics.
 - 3) Coordination of the protective devices to each other and to the source breaker feeding the panel.
 - d. Circuit breakers, fuses, and motor overcurrent protection devices used for branch circuit protection must be UL 508A compliant.
 - 1) Circuit breakers listed under UL 1077 Standard for Supplementary Protectors that do not comply with UL 508A requirements are not acceptable.
 - 2) Miscellaneous, miniature, and micro fuses listed under UL 248 Part 14 that do not comply with UL 508A requirements are not acceptable.
 - 3) Manual motor controllers provided with an instantaneous-trip overcurrent mechanism listed under UL 508 that do not comply with UL 508A requirements are not acceptable.
4. Provide a separate protective device for each powered electrical device:
 - a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
 - b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
 - 1) Size external fuse to open before any I/O-card-mounted fuses.
 - c. Individual discrete inputs shall use a 1/2-ampere fuse.
 - d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
5. Fuses for 4 to 20 milliamperes signals:
 - a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
 - 1) Label shall not cover or interfere with equipment manufacturer's instructions.
 - b. An individual 1/2-ampere fuse for each 4-to-20 milliamperes analog loop powered from the control panel.
 - c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
 - d. Manufacturers: One of the following or equal:
 - 1) Ferraz Shawmut.
 - 2) Littelfuse.
 - 3) Bussmann.

6. Fuse holders:
 - a. Modular type:
 - 1) DIN rail mounting on 35-millimeter rail.
 - 2) Touch-safe design: All connection terminals to be protected against accidental touch.
 - 3) Incorporates blown-fuse indicator.
 - 4) Plug-in style fuse terminals and fuse plugs are not acceptable.
 - b. Provide nameplate identifying each fuse:
 - 1) As specified in Section 26_05_04
 - c. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, UT4-HESI Series.
 - 2) Allen-Bradley, 1492-FB Series B.
 7. Control circuit breakers:
 - a. DIN rail mounting on 35-millimeter rail.
 - b. Manual OPEN-CLOSE toggle switch.
 - c. Rated for 250 VAC.
 - d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
 - e. Current ratings: As required for the application.
 - f. Provide nameplate identifying each circuit breaker:
 - 1) As specified in Section 26_05_04
 - g. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, TMC Series.
 - 2) ABB.
 - 3) Allen-Bradley.
 - 4) Square D.
 8. Electronic circuit protectors:
 - a. Used where a NEC Class 2/SELV power.
 - b. DIN rail mounting on 35-millimeter rail.
 - c. Power source:
 - 1) Rated for 24 VDC.
 - 2) Maximum nameplate rating: 100VA.
 - d. 4 channels to feed 4 independent power feeds to separate devices.
 - e. Output current ratings: As required for the application.
 - f. LED input status indication.
 - g. LED failure status of each channel indication.
 - h. Fail contacts.
 - i. Provide nameplate identifying each circuit electronic circuit protector module:
 - 1) As specified in Section 26_05_04.
 - j. Manufacturers: One of the following or equal:
 - 1) Rockwell Automation 1692-TD014.
 - 2) Puls PISA11 series.
- D. Conductors and cables:
1. Power and control wiring:
 - a. Materials: Stranded, soft annealed copper.
 - b. Insulation: 600 volts type MTW.
 - c. Minimum sizes:
 - 1) Primary power distribution: 12 AWG.

- 2) Secondary power distribution: 14 AWG.
 - 3) Control: 16 AWG.
- d. Color:
 - 1) AC power (line and load): Black.
 - 2) AC power (neutral): White.
 - 3) AC control: Red.
 - 4) AC control: Orange for foreign voltages.
 - 5) DC power and control (ungrounded): Blue.
 - 6) DC power and control (grounded): White with Blue stripe.
 - 7) Ground: Green.
- 2. Signal cables:
 - a. Materials: Stranded, soft annealed copper.
 - b. Insulation: 600 volts, PVC outer jacket.
 - c. Minimum size: 18 AWG paired triad.
 - d. Overall aluminum shield (tape).
 - e. Copper drain wire.
 - f. Color:
 - 1) 2-Conductor:
 - a) Positive (+): Black.
 - b) Negative (-): White and red.
 - 2) 3-Conductor:
 - a) Positive (+): Black.
 - b) Negative (-): Red.
 - c) Signal: White.
 - g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.
- E. Conductor identification:
 - 1. Identify each conductor and cable with unique wire numbers as specified in Section 26_05_05
 - 2. Readily identified without twisting the conductor.
- F. General wiring requirements:
 - 1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
 - 2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
 - 3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
 - 4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
 - 5. Provide power surge protection for all control panels.
 - 6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
 - 7. Provide non-metallic ducts for routing and organization of conductors and cables:
 - a. Provide wiring separation plan.

- b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
 - c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
 - 1) 120 VAC: Grey colored ducts.
 - 2) 24 VDC: White colored ducts.
 - 8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
 - a. Screw-on cable tie mounts.
 - b. Hammer-on cable-tie mounting clips.
 - c. Fingers of the nonmetallic duct.
 - 9. Wire ties:
 - a. No wire ties inside wire duct.
 - b. Use Panduit Cable tie installation tool, with tension control/cutoff.
 - c. Verify cut ends are cut flush filed smooth after installed.
 - 10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
 - 11. Support panel conductors where necessary to keep them in place.
 - 12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
 - 13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
 - a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
 - 14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
 - a. Solenoid valves.
 - b. Instruments both mounted in the control panel and remotely connected to the control panel.
- G. Provide power circuits for all Contractor and Vendor-furnished PLC cabinets in accordance with the PLC and Instrument Power wiring diagrams Indicated on the Drawings or as specified.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

- A. Thermal management:
 - 1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation.
 - 2. Air conditioner:
 - a. Provide solid-state cabinet coolers or air conditioning units on all outdoor panels containing electronic components such as local operator interfaces, panel instruments, programmable logic controllers, or remote I/O.
 - b. Provide filters on intake and exhaust openings.
 - c. Increase panel sizes as needed to accommodate cooling units.

- d. Enclosure rating: NEMA Type 4X.
- e. Closed-loop design.
- f. Power supply: 120 VAC.
- g. Manufacturers: The following or equal:
 - 1) Kooltronic, Guardian X DP Series.
 - 2) ICEcube, Blade series or IECEx/ATEX for Zones 1 and 2.
- 3. Heating:
 - a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
 - 1) The panel is not supplied with 120 VAC power.
 - 2) There are no electronics or moisture-sensitive devices in the enclosure.
 - 3) The panel is smaller than 38 inches high.
- 4. Heat exchanger:
 - a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
 - b. Filterless design to facilitate easy cleaning of the core.
 - c. Mounting: As indicated on the Drawings.
 - d. Manufacturers: The following or equal:
 - 1) Noren, CC Series.
 - 2) ICEcube, Blade series.
- 5. Enclosure temperature switch:
 - a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
 - b. Sensor and electronic enclosure.
 - c. Accuracy: Within 2 degrees Fahrenheit.
 - d. Single contact:
 - 1) Manufacturers: One of the following or equal:
 - a) nVent/Hoffman ATEMNC.
 - b) Pfannenberger FLZ.
 - c) Rittal.
 - e. Dual contact:
 - 1) Manufacturers: The following or equal:
 - a) nVent/Hoffman ADLTEMP.
 - b) Rittal.
- 6. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
 - a. Provide as indicated on the Drawings or as specified.
- 7. Fan ventilation:
 - a. Provide nVent/Hoffman or Rittal fan speed control:
 - 1) Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
 - 2) Provide finger-guard kit.
 - 3) Filter kit with 2 spare filters for each intake fan.
 - 4) Provide bezel and gasket kit.
 - 5) Provide fan shroud.
 - 6) Automatically adjust fan speed depending on remote temperature sensor input.

- 7) 120 VAC, 60 hertz.
- 8) NEMA Type 5-15R cord connections.

B. Panel meters:

- 1. Pointer type:
 - a. Suitable for panel mounting.
 - b. Minimum scale length: 3 inches.
 - c. Calibrated in engineering units.
 - d. Accuracy: Within 2 percent of span.
 - e. NEMA Type 4/IP65 sealed front metal bezel.
 - f. Manufacturers: One of the following or equal:
 - 1) Yokogawa.
 - 2) Red Lion.
- 2. Digital process indicators:
 - a. General:
 - 1) Integral provisions for scaling.
 - 2) Scale to process engineering units.
 - 3) Switch-programmable decimal points.
 - 4) NEMA Type 4/IP65 sealed front bezel.
 - b. Current and voltage indicators:
 - 1) 3-1/2-digit minimum.
 - 2) Minimum character height: 0.5 inches.
 - 3) Accuracy:
 - a) AC/DC volts: Within 0.1 percent of reading plus 2 digits.
 - b) DC current: 4-to-20 milliamperes; within 0.1 percent of reading plus 1 digit.
 - c) DC voltage: 0 to 10 volts; within 0.1 percent of reading plus 1 digit.
 - c. Operating voltage: 120 VAC.
 - d. Operating temperature: 32 degrees to 140 degrees Fahrenheit.
 - 1) Manufacturers: One of the following or equal:
 - a) Red Lion.
 - b) Action Instruments, Visipak.
- 3. Digital bar graph meter:
 - a. Self-contained instruments that display process signals directly in engineering units, both in decimal format and as a bar graph display.
 - b. Suitable for panel mounting.
 - c. LED display:
 - 1) Not less than 3 decimal digits.
 - 2) Not less than a 101-segment LED bar graph.
 - d. Input signal:
 - 1) All conventional current loops and voltage control signals.
 - e. Minimum sample rate of once per second.
 - f. Provisions for field-adjustable scaling and/or offset.
 - g. Accuracy shall be within 1 least-significant digit.
 - h. Manufacturers: One of the following or equal:
 - 1) Ametek Dixson.
 - 2) Yokogawa.
 - 3) Weschler Instruments.

- 4. Counters:
 - a. 6 digits.
 - b. Switch-selectable inputs:
 - 1) Switch contacts.
 - 2) CMOS.
 - 3) TTL.
 - 4) Magnetic pickup.
 - 5) RLC sensors.
 - c. Selectable up/down control via external signal.
 - d. Remote reset.
 - e. Remote inhibit to prevent accumulating counts.
 - f. Programmable to enable or disable front panel reset.
 - g. Non-volatile memory to retain all data upon loss of supply power.
 - h. Sunlight readable.
 - i. Operating temperature: 32 degrees to 122 degrees Fahrenheit.
 - j. Manufacturers: The following or equal:
 - 1) Red Lion, PAX Series.
- C. Pilot devices:
 - 1. General:
 - a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
 - b. Size:
 - 1) 30.5 millimeters.
 - c. Heavy duty.
 - d. Pushbuttons:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
 - e. Selector switches:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - b) Knob type.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
 - 3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
 - f. Pilot lights:
 - 1) Type:
 - a) LED for interior installations.
 - 2) Push to test.
 - 3) Lamp color:
 - a) On/Running/Start: Red.
 - b) Off/Stop: Green.
 - c) Power: White.
 - d) Alarm: Amber.
 - e) Status or normal condition: White.
 - f) Opened: Red.

- g) Closed: Green.
 - h) Failure: Red.
 - 2. Indoor and outdoor areas:
 - a. NEMA Type 4/13.
 - b. Manufacturers: One of the following or equal:
 - 1) Allen-Bradley, Type 800T.
 - 2) Schneider Electric, Class 9001, Type K.
 - 3) General Electric, Type CR104P.
 - 4) IDEC, TWTD Series.
 - 3. Corrosive areas:
 - a. NEMA Type 4X.
 - b. Corrosion resistant.
 - c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.
 - d. Manufacturers: One of the following or equal:
 - 1) Cutler Hammer, Type E34.
 - 2) Schneider Electric, Class 9001, Type SK.
 - 3) Allen-Bradley Type 800H.
 - 4) IDEC, TWTD Series.
 - 4. Hazardous (Classified) Areas/Class I Division 2:
 - a. NEMA Type 4X.
 - b. Corrosion resistant.
 - c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:
 - 1) All contacts contained within a hermetically sealed chamber:
 - a) Pushbuttons.
 - b) Selector switches.
 - c) Push-to-test contacts on pilot lights.
 - 2) UL listed and labeled for Class I Division 2 areas.
 - d. Manufacturers: One of the following or equal:
 - 1) Cutler Hammer, Type E34.
 - 2) Allen-Bradley, Type 800H.
- D. Potentiometer and slidewire transmitters:
- 1. Provide a DC output in proportion to a potentiometer input.
 - 2. Potentiometer input:
 - a. 100 ohms to 100 K ohms.
 - b. Impedance Greater or equal to 1 M ohms.
 - c. Zero turn-up: 80 percent of full-scale input.
 - d. Span turn-down: 80 percent of full-scale input.
 - 3. Field-configurable output:
 - a. Voltage and current: All conventional current loops and voltage control signals.
 - 4. Accuracy including linearity and hysteresis within 0.1 percent maximum at 77 degrees Fahrenheit.
 - 5. Operating temperature: 32 degrees to 131 degrees Fahrenheit.
 - 6. Supply power: 9 to 30 VDC.
 - 7. Manufacturers: The following or equal:
 - a. Phoenix Contact, Mini Analog Pro.
 - b. Allen Bradley Type 800T-U29.

- E. Signal isolators and converters:
1. Furnish signal isolators that provide complete isolation of input, output, and power input:
 - a. Minimum isolation level: 1.0 kilovolts AC/50 hertz for at least 1 minute.
 - b. Adjustable span and zero.
 - c. Accuracy: Within 1.0 percent of span.
 - d. Ambient temperature range: -4 degrees to 149 degrees Fahrenheit.
 2. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, Mini Analog Pro.
 - b. Acromag, 1500, 600T, 800T, Flat Pack, or ACR Series.
 - c. Action Instruments, Q500 Series or Ultra SlimPakII.
 - d. AGM Electronics, Model TA-4000.
 - e. Moore Industries, MIT 4-Channel.
- F. Relays:
1. General:
 - a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
 - b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
 - c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.
 2. General purpose:
 - a. Magnetic control relays.
 - b. NEMA ratings:
 - 1) 300 volts.
 - 2) 10 Amps thermal continuous test current.
 - 3) 60 Amps make.
 - 4) 6 Amps break.
 - c. Plug-in type.
 - d. LED indication for energization status.
 - e. Coil voltages: As required for the application.
 - f. Minimum poles: DPDT.
 - g. Touch-safe design: All connection terminals to be protected against accidental touch.
 - h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
 - i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
 - j. Relays with screw-type socket terminals.
 - k. Provide additional (interposing) relays when the following occurs:
 - 1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
 - 2) Higher contact rating is required in order to interface with starter circuits or other equipment.
 - l. DIN rail mounting on 35-millimeter rail.
 - m. Ice-cube-type relays with retainer clips to secure relay in socket.
 - n. Integrated label holder for device labeling.
 - o. Manufacturers: One of the following or equal:
 - 1) Potter and Brumfield: Type KRP or KUP.
 - 2) IDEC: R* Series (* = H, J, R, S, U).

- 3) Allen-Bradley: Type 700 HC.
- 4) Square D: Type K.
- 3. Terminal block relays:
 - a. Magnetic control relays.
 - b. For use as an interposing relay for PLC based discrete I/O signals.
 - c. NEMA ratings:
 - 1) 250 volts.
 - 2) 6 Amps continuous.
 - 3) 1,500 volt-amperes make.
 - d. Plug-in type.
 - e. LED indication for energization status.
 - f. Coil voltages: As required for the application.
 - g. Minimum poles: SPDT.
 - h. Touch-safe design: All connection terminals to be protected against accidental touch.
 - i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
 - j. Relays with screw-type socket terminals.
 - k. DIN rail mounting on 35-millimeter rail.
 - l. Integrated label holder for device labeling.
 - m. Manufacturer: One of the following or equal:
 - 1) Phoenix Contact PLC Series.
 - 2) Eaton XR TBR Series.
 - 3) IDEC RV8H Series.
 - 4) Allen-Bradley Type 700 HL TBR Series.
- 4. Latching:
 - a. Magnetic-latching control relays.
 - b. NEMA ratings:
 - 1) 300 volts.
 - 2) 5 Amps continuous.
 - 3) 360 volt-amperes make.
 - 4) 320 volt-amperes break.
 - c. Plug-in type.
 - d. DIN rail mounting on 35-millimeter rail.
 - e. Coil voltage: As required for the application.
 - f. Minimum poles: 2 PDT; as required for the application. Plus 1 spare pole.
 - g. Touch-safe design: All connection terminals to be protected against accidental touch.
 - h. Clear cover for visual inspection.
 - i. Provide retainer clip to secure relay in socket.
 - j. Manufacturers: One of the following or equal:
 - 1) Square D, 8501, Type K.
 - 2) IDEC, RR2KP Series.
- 5. Time delay:
 - a. Provide time-delay relays to control contact transition time.
 - b. Contact rating:
 - 1) 240 volts.
 - 2) 10 Amps continuous.
 - 3) 3,600 volt-amperes make.
 - 4) 360 volt-amperes break.

- c. Coil voltage: As required for the application.
 - d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off-delay:
 - 1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
 - e. Minimum poles: 2 PDT.
 - f. Units include adjustable dial with graduated scale covering the time range in each case.
 - g. Minimum timing range: 0.1 seconds to 10 minutes, or as required for the application.
 - h. Manufacturers: One of the following or equal:
 - 1) IDEC, RTE Series.
 - 2) Tyco Electronics, Agastat 7000 Series (pneumatic).
 - 3) Allen-Bradley, Type 700-HR.
- G. Terminal blocks:
- 1. DIN rail mounting on 35-millimeter rail.
 - 2. Rated for 15 amperes at 600 volts.
 - 3. Screw terminal type.
 - 4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
 - 5. Finger-safe protection for all terminals for conductors.
 - 6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
 - 7. Terminals: Plainly identified to correspond with markings on the diagrams:
 - a. Permanent machine-printed terminal identification.
 - 8. Disconnect-type field signal conductor terminals with socket/screw for testing.
 - 9. Identify terminals suitable for use with more than 1 conductor.
 - 10. Position:
 - a. So that the internal and external wiring does not cross.
 - b. To provide unobstructed access to the terminals and their conductors.
 - 11. Provide minimum 25-percent spare terminals.
 - 12. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, UT4 Series.
 - b. Allen-Bradley, 1492 Series.
- H. DIN rail grounding:
- 1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
 - a. Mount to DIN rail via grounding foot with mounting screw.
 - b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
 - c. Not be used for grounding signal cable shields.
 - 2. Screw terminal type.
 - 3. DIN rail mounting on 35-millimeter rail.

4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
 5. Finger-safe protection for all terminals for conductors.
 6. Terminals: Plainly identified to correspond with markings on the diagrams:
 - a. Permanent machine-printed terminal identification.
 7. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, USKLG Series.
 - b. Allen-Bradley, 1492-JG Series.
- I. Wire duct:
1. Provide flame retardant plastic wiring duct, slotted with dust cover.
 2. Type:
 - a. Wide slot.
 - b. Narrow slot.
 - c. Round hole.
 3. Manufacturers: The following or equal:
 - a. Panduit.
 - b. Phoenix Contact.
 - c. Thomas & Betts.
 - d. Iboco.
- J. DIN rail:
1. Perforated steel.
 2. 35 mm width.
 3. 15 mm deep.
 4. Provide 2-inch offset using one of the following:
 - a. Offset brackets.
 - b. Preformed standoff DIN Rail Channel.
- K. Surge protection devices (SPD):
1. 120 VAC control panel power SPD:
 - a. Provide SPD for panel 120 VAC power entrances:
 - 1) Non-faulting and non-interrupting design.
 - 2) Provide line to neutral and neutral to ground surge protection.
 - b. Provide surge protection at secondary of main circuit breaker:
 - 1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
 - 2) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
 - c. DIN rail mounting.
 - d. Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
 - 1) Gastight connections.
 - 2) Visual status indication of MOV status on the input and output circuits.
 - 3) Dry contact rated for remote status indication.
 - e. Approvals:
 - 1) Tested in accordance with IEC 61643-11.
 - 2) Tested in accordance with UL 1283.

- 3) Tested in accordance with UL 1449.
- 4) Surge protection minimum requirements: Withstand a minimum 10-kA test current of an 8/20 μ s waveform in accordance with IEEE C62.41.1 Category C Area.
- f. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, Type SFP Filter.
 - 2) Sola HD, STFE Elite series.
 - 3) Rockwell, 4983-DC series.
 - 4) ASCO, Model 277.
2. 24 VDC control panel power SPD:
 - a. Provide SPD for 24VDC power circuits.
 - b. Provide surge protection at DC power supply output.
 - c. DIN rail mounting.
 - d. Attach wiring to the SPD by means of a screw-type cable clamping terminal block:
 - 1) Optical status indicator.
 - 2) Dry contact rated for remote status indication.
 - e. Approvals:
 - 1) Tested in accordance with IEC 61643-11.
 - f. Manufacturers: One of the following or equal:
 - 1) Field instruments that require auxiliary power:
 - a) Emerson, Model 265 (SLAC) series.
 - b) Phoenix Contact, Plugtrab PLT--SEC-T3-24-FM-UT.
 - 2) Loop powered field instruments:
 - a) Emerson/Edco, Model SS65-036-2.
3. Panel mounted control, signal, and data line SPD:
 - a. General:
 - 1) This section applies to SPD located in a control panel, field panel, network junction box, or marshalling panel.
 - 2) Approvals:
 - a) Tested in accordance with IEC 61643-21.
 - b) Tested in accordance with UL 497B.
 - 3) SPD shall consist of 2 parts:
 - a) Base module:
 - (1) DIN rail mounting.
 - (a) Grounded to DIN rail via mounting rail foot.
 - b) Plug protection module:
 - (1) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
 - 4) Provide indirect shield ground style SPD unless otherwise noted.
 - 5) Provide ability to locally identify and indicate SPD health.
 - 6) SPD shall be provided with controller module with dry contact for remote status monitoring of SPD device health.
 - 7) SPD modules shall be compatible with signal, communication bus type, data type, or control power being protected.
 - 8) Provide dedicated SPD for each signal, communication bus type, or data line being protected.
 - b. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, Plugtrab PT-IQ Series.
 - 2) Dehn, Blitzductor XTU Series.

4. Copper Ethernet SPD:
 - a. Protects network equipment from lightning or other surge events.
 - b. Suitable for Gigabit networks.
 - c. Shielded RJ-45 ports.
 - d. Compliant with PoE standards IEEE 802.3af and 802.3at.
 - e. Nominal discharge surge current: 10 kA.
 - f. Approvals:
 - 1) Tested in accordance with IEC 61643-21.
 - 2) Tested in accordance with UL 497B.
 - g. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, DT-LAN-CAT6+.
 - 2) Citel, MJ8-C6A.
 - 3) Weidmuller, VDATA CAT6.
 - 4) Eaton/MTL, ZoneBarrier High Energy Ethernet.
5. Field device mounted SPD:
 - a. Conduit entry mounting.
 - 1) Provide parallel or through wiring configurations as required by the application.
 - a) Use parallel wiring configuration if there is an available cable gland at the device.
 - b) Use through wiring configuration if there is no available cable gland at the device.
 - 2) Provide Screw connections compatible with field device.
 - b. NEMA 4X stainless steel material housing.
 - c. Approvals:
 - 1) Tested in accordance with IEC 61643-21.
 - d. 4-wire field device:
 - 1) Module shall provide simultaneous protection of signal cable, communication bus, or data line, and power supply line.
 - a) Maximum continuous voltage:
 - (1) DC:
 - (a) Signal: 32 VDC.
 - (b) Power supply: 255 VDC.
 - (2) AC:
 - (a) Signal: 22.6 VAC.
 - (b) Power supply: 255 VAC.
 - 2) Manufacturers: The following, engineer knows of no equal:
 - a) Endress+Hauser, HAW569-CB2C.
 - e. 2-wire or 3-wire field device:
 - 1) Module shall provide protection for the signal cable, communication bus or data line.
 - 2) Manufacturers: One of the following or equal:
 - a) Endress+Hauser, HAW569 Series.
 - b) Phoenix Contact, Surgetrab S-PT Series.
 - c) Eaton/MTL, TP Series.

L. Horns and beacons:

1. Beacons/horn combination units:
 - a. Manufacturers: The following or equal:
 - 1) Edwards, Multi-Status LED 108i with tone module.
 - 2) Federal Signals, AV1ST Strobe Combination Audible/Visual Signal.
 - b. LED Colors: Red, Green, and Amber.
 - c. Power: 120VAC.
 - d. Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
 - e. Horn rated 80 dB minimum at 10 feet.
2. Dedicated beacon unit:
 - a. Manufacturers: One of the following or equal:
 - 1) Federal Signal Corp., Starfire Series.
 - 2) Allen-Bradley, 855 B *-* 10 Series.
 - 3) Edwards, 102 Series.
3. Dedicated horn unit:
 - a. Electromechanical:
 - 1) Manufacturers: One of the following or equal:
 - a) Federal Signal, 350 or 31X Series.
 - b) Edwards, 878EX or 879EX Series.
 - b. Electronic:
 - 1) Manufacturers: One of the following or equal:
 - a) Federal Signal, 300GCX or 300X Series.
 - b) Allen-Bradley, 855H or 855XH Series.
 - c) Edwards, 5530M or 5533MD Series.
 - c. Rated for 80 dB minimum at 10 feet.

M. Power supplies:

1. Design power supply system so that either the primary or backup supply can be removed, repaired or replaced, and returned to service without disrupting the system operation.
2. Convert 120 VAC to 24-volt DC or other DC voltages required or as required for the application.
3. Provide redundant backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure in either a 1+1 or N+1 configuration as required:
 - a. Provide automatic switchover upon module failure.
 - b. Alarm contacts monitored by the PLC.
5. Provide protective isolation between power supply units either by means of Diodes, Diode Modules, MOSFET Modules, or use power supplies with built in redundancy. Power supplies with built in redundancy must actively isolate each power supply and be designed as such.
6. Sized to provide 40-percent excess rated capacity.
7. UL 508C listed to allow full-rated output without de-rating.
8. Provide fuse or short-circuit protection.
9. Provide a minimum of 1 set of dry contacts for each power supply configured to change state on failure for monitoring and signaling purposes.

10. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change.
 11. Operating temperature range: 32 degrees to 140 degrees Fahrenheit.
 12. Touch-safe design: All connection terminals to be protected against accidental touch.
 13. DIN rail mounting on 35-millimeter rail:
 - a. Mount the power supply in the proper orientation as recommended by the manufacturer to ensure adequate thermal dispersion without derating the power supply.
 14. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
 15. Manufacturers: One of the following or equal:
 - a. Fully redundant:
 - 1) Phoenix Contact, Quint Power Supply with SFB technology.
 - a) Phoenix Contact, Quint.
 - 2) IDEC, PS5R Series:
 - 3) Sola.
 - 4) PULS.
 - b. Redundancy module:
 - 1) Phoenix contact, o-ring redundancy module.
- N. Intrinsic safety barriers:
1. Transformer isolated barrier:
 - a. Containing a transformer to provide complete:
 - 1) Isolation between the safe and hazardous areas for loop-powered devices.
 - 2) 3-way isolation between the safe area, hazardous area, and power supply powered devices.
 - b. Resistor for current limitation.
 - c. Fuses for short-circuit protection.
 - d. Provide barriers with pluggable connectors that are coded for easy replacement.
 - e. Transmission error shall be less than or equal to 0.1 percent of full-scale.
 - f. DIN rail mounting on 35-millimeter rail.
 - g. Approvals:
 - 1) FM.
 - 2) UL 913.
 2. Types:
 - a. Switch isolators:
 - 1) Designed and approved for use with discrete inputs.
 - 2) Supply power: 20 to 30 VDC.
 - 3) Output to track input.
 - 4) LED in the cover to indicate the status of the input.
 - 5) Selector switch to change the logic of the input.
 - 6) Input: Dry contact.
 - 7) Output: SPDT relay.
 - b. Transmitter and converters for use with 4- to 20-milliampere signals without Hart® communications capability:
 - 1) Designed and approved for use with 4- to 20-milliampere analog signals.

- 2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
 - 3) Supply voltage: 20 to 30 VDC.
 - c. Transmitter and converters for use with 4- to 20-milliampere signals with Hart® communications capability:
 - 1) Designed and approved for use with 4- to 20-milliampere analog signals.
 - 2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
 - 3) Transfer digital signals from the hazardous area to the safe area.
 - 4) Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.
 - 5) Supply voltage: 20 to 30 VDC.
 - 3. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, MACX Series.
 - b. Pepperl + Fuchs.
- O. Limit switches:
- 1. NEMA Type 4X.
 - 2. AC contact rating 120 volts, 10 A.
 - 3. DC contact rating 125 volts, 0.4 A.
 - 4. Provide robust actuation mechanism not prone to degradation.
 - 5. Provide complete actuator mechanism with all required hardware.
 - 6. Allows for contact opening even during contact weld condition.
 - 7. UL approved.
 - 8. Operating temperature range: 0 degrees to 230 degrees Fahrenheit).
 - 9. Manufacturers: One of the following or equal:
 - a. Allen-Bradley, 802 Series.
 - b. Honeywell, HDLS Series.
 - c. Omron, D4 Series.
 - d. Eaton, E47, E49, E50.
 - e. ABB.
- P. Current switches:
- 1. Operate from 120-VAC supply voltage.
 - 2. 1 normally open and normally closed contacts.
 - 3. Adjustable current setting.
 - 4. Manufacturers: The following or equal:
 - a. Zelio®, RM35.
 - b. Phoenix Contact, EMD Series.
- Q. Current transmitters:
- 1. Input current range: As required.
 - 2. Output: 4-20 mA or 0-10 V.
 - 3. Operate from 24 VDC supply voltage.
 - 4. Output overload protected.
 - 5. Accuracy: Within 0.5 percent full-scale.

6. Ripple and Noise: 1 percent Max., peak to peak.
 7. Frequency: 50/60 hertz.
 8. Manufacturer:
 - a. Phoenix Contact: Mini Analog Pro Series.
 - b. CR Magnetics: CR4320 series.
 - c. American Aerospace: 1070 Series.
- R. Panel mount quick connector:
1. Keyed insertion plug.
 2. Threaded cap to protect connection when not in use.
 3. Material: Stainless steel.
 4. Pre-wired pigtails.
 5. Indoor/outdoor:
 - a. Rating: Meets or exceeds panel rating.
 - b. Manufacturers: One of the following or equal:
 - 1) Amphenol.
 - 2) Sealcon.
 6. Hazardous (Classified) Areas:
 - a. UL listed and labeled for area as indicated on the Drawings.
 - b. Manufacturers: The following or equal:
 - 1) Amphenol HDE Series.

2.08 ACCESSORIES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.
- C. Provide floor stands or legs with a minimum height of 12 inches where needed or as indicated on the Drawings.
- D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.
- E. Provide nameplate to each panel as indicated on the Drawings:
 1. Provide as specified in Section 26_05_04 on all internal and external instruments and devices.
 2. Provide a nameplate with the following markings that is plainly visible after installation:
 - a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
 - b. Supply voltage, phase, frequency, and full-load current.
 - c. Power source or circuit ID.
 - d. Short-circuit current rating of the panel based on one of the following:
 - 1) Short-circuit current rating of a listed and labeled assembly.
 - 2) Short-circuit current rating established utilizing an approved method.

- F. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
1. Safety plate glass.
 2. Secured by rubber locking seal.
 3. Allow full viewing of devices issuing visual process data or diagnostics.
- G. Lighting:
1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
 - a. Covered or guarded.
 - b. Provide On-Off door-activated switches where indicated on the Drawings.
 - c. 120-volt, single-phase, 15-amp style plug.
 - d. Provide 4,000 K, 900 Lumens LED fixture.
 - 1) Provide additional fixtures for every 36 inches of width.
- H. Receptacles:
1. Provide 1 duplex receptacle located every 6 feet of enclosure width, spaced evenly along the back mounting panels.
 2. GFCI, 120-volt, single-phase, 15-amp style plug.
 3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.
- I. Grounding:
1. Provide the following:
 - a. Grounding strap between enclosure doors and the enclosure.
 - b. Equipment grounding conductor terminals.
 - c. Provide equipment grounding busbar with lugs for connection of all equipment grounding wires.
 - d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.
 2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND", the letter "G", or the color green.
 3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
 4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
 5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
 6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
 7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
 8. Unless otherwise noted, connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
 9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
- J. Provide sunshades and insulation for all outdoor installations.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES

A. Finishes:

1. Metallic (non-stainless):
 - a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
 - b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
 - c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
 - d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
2. Stainless steel:
 - a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

2.12 SOURCE QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
 1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.
- B. Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.

- C. Provide concrete housekeeping pads for freestanding enclosures:
 - 1. Refer to the structural typical details.
- D. Install gasket and sealing material under panels with floor slab cutouts for conduit:
 - 1. Undercoat floor-mounted panels.
- E. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.
- F. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.
- G. Protect all wiring from sharp edges and corners.
- H. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule but shall be shown on the Loop Drawings prepared by the Contractor.
- I. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.
- J. Side panels:
 - 1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIRS/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_71_15

FLOW MEASUREMENT: MAGNETIC FLOWMETERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Full-body magnetic flowmeters.
- B. Provide all instruments identified in the Contract Drawings.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. International Organization for Standardization (ISO):
 - 1. 9000 - Quality management systems -- Fundamentals and vocabulary.
 - 2. 17025 - General requirements for the competence of testing and calibration laboratories.
- C. National Institute of Standards and Technology (NIST).
- D. NSF International (NSF).

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

- A. Furnish submittals as specified in Sections 01_33_00 - Submittal Procedures and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Include sizing information from the manufacturer that includes:
 - 1. Chart of the measurement error from zero to maximum measured volumetric flow range indicated in data sheets.
 - 2. Indication of all input parameters and their values used in the calculations.

1.05 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

- B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Endress+Hauser:
 - a. Promag W flowtube with 300/400/500 series transmitter.
 - b. Promag H flowtube with 300/400/500 series transmitter.
 - 2. Emerson, Rosemount 8750W.
 - 3. Krohne, IFC.
 - 4. Yokogawa, AXF.
 - 5. ABB, Watermaster.

2.02 MANUFACTURED UNITS

- A. As specified in this Section including Attachment A - ISA Data Sheet - Flow Measurement: Magnetic Flowmeters.

B. Magnetic flowmeter:

1. General:

- a. Magnetic flowmeters obtain the flow velocity by measuring the changes of induced voltage of the conductive fluid passing across a controlled magnetic field.
- b. Complete zero stability shall be an inherent characteristic of the flowmeter system.
- c. Include for each magnetic flow metering system:
 - 1) A metering tube with electrodes (sensor).
 - 2) Signal cable.
 - 3) Transmitter integral or remote as indicated on the Drawings.
 - 4) Flowmeter grounding rings.

2. Performance requirements:

- a. Accuracy:
 - 1) 0.25 percent of flow rate from 10 to 100 percent of full-scale for velocities ranging between 1.9 to 10 feet per second.
- b. Repeatability:
 - 1) 0.25 percent of rate.

3. Element:

a. Metering tube:

- 1) Constructed of carbon steel or Type 304 stainless steel (unless specifically noted otherwise in Attachment A - ISA Data Sheet - Flow Measurement: Magnetic Flowmeters) with flanged connections to match with piping material.
- 2) Liner material in conformance with:
 - a) Manufacturer's recommendations for the intended service.
 - b) NSF certified for all drinking water applications.
- 3) Electrodes type and material in conformance with:
 - a) Manufacturer's recommendations for the intended service.
 - b) Utilize a minimum of 2, self-cleaning electrodes.
- 4) Meter terminal housing NEMA Type 4X, unless installed in locations such as vaults that will experience submergence. In those applications NEMA 6P is required.
 - a) Unless specifically noted otherwise in Attachment A - ISA Data Sheet - Flow Measurement: Magnetic Flowmeters.
- 5) Meter coating consisting of epoxy painted finish.
- 6) Components:
 - a) 2 grounding rings:
 - (1) Which are in conformance with the manufacturer's bore and material recommendation for the meter's intended service.

4. Transmitter:

- a. Power supply:
 - 1) As indicated in the data sheets.
 - 2) Power consumption: 60 VA maximum.
- b. Outputs:
 - 1) As noted in Attachment A - ISA Data Sheet - Flow Measurement: Magnetic Flowmeters.
 - 2) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
- c. Microprocessor-based signal converter/transmitter.

- d. Utilize DC pulse technique to drive flux-producing coils.
- e. Contain a 6-digit display for flow rate, percent of span, and totalizer.
- f. Operator keypad interface.
- g. Integral zero return to provide consistent zero output signals in response to an external dry contact closure.
- h. Integral low flow cut-off zero return.
- i. Programmable parameters including:
 - 1) Meter size.
 - 2) Full-scale flow rate.
 - 3) Magnetic field frequency.
 - 4) Time constant.
- j. Data retention for a minimum of 5 years without auxiliary main or battery power.
- k. Self-diagnostics and automatic data checking.
- l. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
- m. Ambient operating temperature limits of -5 to 140 degrees Fahrenheit (-20 to 60 degrees Celsius).
- n. Enclosure:
 - 1) Non-hazardous area:
 - a) NEMA Type 4X.
 - 2) Class I Division 1 area:
 - a) Explosion-proof/Class I Division 1 rated.
 - b) NEMA 4X with intrinsic safe circuits.
 - 3) Class I Division 2 area:
 - a) Explosion-proof/Class I Division 1 rated.
 - b) Class I Division 2 rated.
 - c) NEMA 4X with intrinsic safe circuits.
 - 4) For more information, see Attachment A - ISA Data Sheet - Flow Measurement: Magnetic Flowmeters.
- o. The transmitter should support commissioning options via a service interface or via an internal web server accessible through an RJ-45 Ethernet port.
- p. The transmitter should retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure.
- q. Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.

2.03 ACCESSORIES

- A. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.
- B. Provide sunshades for all transmitters located outdoors.
- C. Provide galvanic isolation gaskets, nylon/Teflon™ flange bolt insulation bushings and nylon washers on all meters installed on pipes with cathodic protection.
- D. Furnish 1 spool piece for every size of magnetic flow tube being provided.

2.04 SOURCE QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Factory calibrate each flow metering system at a facility that is traceable to the NIST. ISO-17025 accredited test facility with certified accuracy traceable to NIST.
- C. Evidence of accreditation shall originate from a national verification agency such as A2LA.
- D. FM approval certification or equal when installed in classified areas.
- E. A real-time computer generated printout of the actual calibration date indication actual velocities and as read values of the flow tube.
 - 1. Flow calibration report of the manufacturers flow lab calibration procedure shall be shipped with the meter system.
 - 2. Minimum calibration shall be a 3 point calibration including 1, 3, and 10 feet per second velocities for every meter and transmitter system.
 - 3. Manufacturer shall archive all calibration reports for future reference.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. For instruments located outdoors or where instrument elements and transmitters are separated by conduit located outside the building envelope, provide surge protection devices at the transmitters.

3.04 FIELD QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide manufacturer's services to perform installation inspection.

3.05 ADJUSTING

- A. Field Verification:
 - 1. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.
 - 2. The transmitter and sensor to include a method to verify flow meter performance to the original manufacturer specifications.

3. Verification should be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
4. The verification report should be compliant to common quality systems such as ISO 9000 to prove reliability of the meter specified accuracy.
5. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Demonstrate performance of all instruments to the Engineer before commissioning.

3.08 PROTECTION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES

- A. Instrument Data Sheets included in this Section.
- B. The provided information does not necessarily include all required instruments.
- C. Provide all instruments identified in the Contract Documents:
 1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATA SHEET - FLOW MEASUREMENT: MAGNETIC FLOWMETERS



PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG FIT-101 (FE-101)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 00N01
SERVICE MAGNETIC FLOW METER

MEASURING PRINCIPLE MAGNETIC
PLC PLC-DIW1
POWER LOCATION PCM
TYPICAL DETAIL(S) NF130, NF135

CONNECTION

LINE SIZE [*]
LINE MATERIAL [*]

PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL [*]

FLUID

FLUID [*]
NOMINAL FLOW [*]
FLOW RANGE 0-16 MGD

PRESSURE 125 PSI
TEMPERATURE N/A
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-101
ENCLOSURE CLASS IP68
HAZARDOUS APPROVALS N/A
TUBE SIZE 24"
TUBE MATERIAL MFR. STD.

PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-101
MOUNTING REM
ENCLOSURE CLASS NEMA 4X
POWER 120VAC-1P
AMBIENT TEMPERATURE [*]
OUTPUT ETHERNET/IP
SURGE PROTECTION YES

HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

[*]



PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

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GENERAL

TAG FIT-102 (FE-102)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 00N01
SERVICE MAGNETIC FLOW METER

MEASURING PRINCIPLE MAGNETIC
PLC PLC-DIW2
POWER LOCATION PCM
TYPICAL DETAIL(S) NF130, NF135

CONNECTION

LINE SIZE [*]
LINE MATERIAL [*]

PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL [*]

FLUID

FLUID [*]
NOMINAL FLOW [*]
FLOW RANGE 0-16 MGD

PRESSURE 125 PSI
TEMPERATURE N/A
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-102
ENCLOSURE CLASS IP68
HAZARDOUS APPROVALS N/A
TUBE SIZE 24"
TUBE MATERIAL MFR. STD.

PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-102
MOUNTING REM
ENCLOSURE CLASS NEMA 4X
POWER 120VAC-1P
AMBIENT TEMPERATURE [*]
OUTPUT ETHERNET/IP
SURGE PROTECTION YES

HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

[*]



PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

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GENERAL

TAG FIT-103 (FE-103)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 00N02
SERVICE MAGNETIC FLOW METER

MEASURING PRINCIPLE MAGNETIC
PLC PLC-DIW1
POWER LOCATION PCM
TYPICAL DETAIL(S) NF130, NF135

CONNECTION

LINE SIZE [*]
LINE MATERIAL [*]

PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL [*]

FLUID

FLUID [*]
NOMINAL FLOW [*]
FLOW RANGE ____-____ GPM

PRESSURE 125 PSI
TEMPERATURE N/A
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-103
ENCLOSURE CLASS IP68
HAZARDOUS APPROVALS N/A
TUBE SIZE 1"
TUBE MATERIAL MFR. STD.

PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-103
MOUNTING REM
ENCLOSURE CLASS NEMA 4X
POWER 120VAC-1P
AMBIENT TEMPERATURE [*]
OUTPUT ETHERNET/IP
SURGE PROTECTION YES

HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

[*]



PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG FIT-104 (FE-104)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 00N02
SERVICE MAGNETIC FLOW METER

MEASURING PRINCIPLE MAGNETIC
PLC PLC-DIW1
POWER LOCATION PCM
TYPICAL DETAIL(S) NF130, NF135

CONNECTION

LINE SIZE [*]
LINE MATERIAL [*]

PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL [*]

FLUID

FLUID [*]
NOMINAL FLOW [*]
FLOW RANGE ____ - ____ GPM

PRESSURE 125 PSI
TEMPERATURE N/A
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-104
ENCLOSURE CLASS IP68
HAZARDOUS APPROVALS N/A
TUBE SIZE 1"
TUBE MATERIAL MFR. STD.

PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-104
MOUNTING REM
ENCLOSURE CLASS NEMA 4X
POWER 120VAC-1P
AMBIENT TEMPERATURE [*]
OUTPUT ETHERNET/IP
SURGE PROTECTION YES

HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

[*]



PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG FIT-110 (FE-110)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 10N01
SERVICE IQ MAGNETIC FLOW METER

MEASURING PRINCIPLE MAGNETIC
PLC PCM
POWER LOCATION PCM
TYPICAL DETAIL(S) NF130, NF135

CONNECTION

LINE SIZE [*]
LINE MATERIAL [*]

PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL [*]

FLUID

FLUID [*]
NOMINAL FLOW [*]
FLOW RANGE 0-16 MGD

PRESSURE 125 PSI
TEMPERATURE N/A
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-110
ENCLOSURE CLASS IP68
HAZARDOUS APPROVALS N/A
TUBE SIZE 10"
TUBE MATERIAL MFR. STD.

PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-110
MOUNTING REM
ENCLOSURE CLASS NEMA 4X
POWER 120VAC-1P
AMBIENT TEMPERATURE [*]
OUTPUT ETHERNET/IP
SURGE PROTECTION YES

HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

[*]

SECTION 40_72_36

LEVEL MEASUREMENT: CAPACITANCE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Level measurement devices using the principle of admittance/capacitance for level measurement.
 - 2. For discrete measurement of liquid, slurry and granular levels.
 - 3. For analog measurement of liquid, slurry and granular levels.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

- A. Furnish submittals as specified in Sections 01_33_00 - Submittal Procedures and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide complete documentation covering the traceability of all calibration instruments.

1.04 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Manufacture instrument facilities certified to the quality standards of ISO Standard 9001 – Quality Systems – Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

- A. Project environmental conditions as specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

- A. Furnish all parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide all instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

- A. Continuous RF admittance/capacitance level:
 - 1. One of the following or equal:
 - a. Drexelbrook, Universal Lite 509-15 Series.
 - b. Delta Controls, Model TS173.
 - c. Endress + Hauser, Liquicap Level Transmitter, Models FMI51/52.

2.04 MANUFACTURED UNITS

- A. As specified in this Section including Attachment A - ISA Data Sheet - Level Measurement: Capacitance.

- B. Discrete signal RF admittance/capacitance level measurement:
1. General:
 - a. RF signal enables a very small current flow from the sensor to reference ground.
 - 1) A change in RF admittance indicates presence or absence of the measured material.
 - 2) Transmitter circuitry enables the instrument to ignore the effect of buildup of material coating on the sensing element.
 - b. Single-point level switch sensing level of liquid, slurries, or granular materials.
 - c. Sensing interface between 2 liquids with significantly different dielectric constants (1 liquid must be non-conductive).
 2. Performance requirements:
 - a. Accuracy:
 - 1) Within 0.25-inch.
 - b. Repeatability:
 - 1) Within 0.1-inch.
 3. Element:
 - a. Rigid probe or flexible cable with weight for large container liquid applications.
 - b. Probe and insulation material must conform to measured material chemical compatibility as indicated in Attachment A - ISA Data Sheet - Level Measurement: Capacitance or the instrument index.
 4. Transmitter:
 - a. Power supply:
 - 1) 120 VAC.
 - 2) 24 VDC.
 - 3) Power consumption: 15 VA maximum.
 - b. Outputs:
 - 1) Isolated 4 to 20 milliamperes DC with HART communication protocol.
 - 2) Relay outputs:
 - a) 2 SPDT Form C contacts.
 - b) Rated min 5 amperes at 250 VAC.
 - c) Programmable for adjustable hysteresis.
 - c. Enclosure:
 - 1) Non-hazardous area:
 - a) NEMA Type 4X.
 - 2) Class I Division 1 area:
 - a) Explosion-proof/Class I Division 1 rated.
 - b) NEMA 4X with intrinsic safe circuits.
 - 3) Class I Division 2 area:
 - a) Explosion-proof/Class I Division 1 rated.
 - b) Class I Division 2 rated.
 - c) NEMA 4X with intrinsic safe circuits.
 - 4) For more information, see Attachment A - ISA Data Sheet - Level Measurement: Capacitance.
 - d. Operating temperature range from -28 to 155 degrees Fahrenheit.

2.05 ACCESSORIES

- A. Provide sunshades for outdoor installations.

2.06 SOURCE QUALITY CONTROL

- A. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
 - 1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.
- B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.03 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning.

3.04 SCHEDULES

- A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
 - 1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATA SHEET - LEVEL MEASUREMENT: CAPACITANCE

PROJECT INFORMATION

PLANT
PROJECT 7126I10

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG LSL-102 (LE-102)
SPECIFICATION NUMBER 17204
DRAWING NUMBER 00N01
SERVICE CAPACITANCE

MEASURING PRINCIPLE CAPACITANCE
PLC PLC-DIW1
TYPICAL DETAILS NL114

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE ____ FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-102
ELEMENT HAZ. MATERIALS N/A
SUBMERGENCE DETECTION NO
HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X
ELEMENT MATERIAL MFR. STD.
TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LSL-102
MOUNTING [*]
POWER 24VDC
AMBIENT TEMPERATURE [*]
SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A
ENCLOSURE CLASS NEMA 4X
OUTPUT RELAY
MEASUREMENT APPL LEVEL

NOTES

[*]

PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG LSL-104 (LE-104)
SPECIFICATION NUMBER 17204
DRAWING NUMBER 00N01
SERVICE CAPACITANCE

MEASURING PRINCIPLE CAPACITANCE
PLC PLC-DIW2
TYPICAL DETAILS NL114

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE ___ FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-104
ELEMENT HAZ. MATERIALS N/A
SUBMERGENCE DETECTION NO
HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X
ELEMENT MATERIAL MFR. STD.
TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LSL-104
MOUNTING [*]
POWER 24VDC
AMBIENT TEMPERATURE [*]
SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A
ENCLOSURE CLASS NEMA 4X
OUTPUT RELAY
MEASUREMENT APPL LEVEL

NOTES

[*]

SECTION 40_72_76

LEVEL MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Conductivity level switch.
 - 2. Capacitance level switch.
 - 3. Tuning fork level switch.
 - 4. Ball float level switch.
 - 5. Displacement float level switch.
 - 6. Ultrasonic level switch.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide complete documentation covering the traceability of calibration instruments.

1.04 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.
- C. Manufacture instrument facilities certified to the quality standards of ISO 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or Specifications.

1.08 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

- A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

- A. One of the following or equal:
 - 1. Conductivity level switch:
 - a. Standard applications:
 - 1) Ametek Drexelbrook, Model 6012/6013 probes with Series 5200 relay.
 - 2) E+H, Liquipoint FTW.
 - 3) Warrick Controls, Model 3 series probes with 16 VM relay.
 - b. Intrinsically safe:
 - 1) B/W, Control High Sensitivity Series 5200 N7.
 - 2) Warrick Controls, Model 27.
 - 2. Capacitance level switch:
 - a. E+H, Liquicap M FTI51/FTI52.

3. Tuning fork level switch:
 - a. Ametek Drexelbrook, TF-100 Series.
 - b. E+H, Liquiphant.
 - c. Siemens, Sitrans LVL200 Series Switch.
4. Ball float level switch:
 - a. Anchor Scientific Inc., Ecofloat/Solofloat.
 - b. E+H, Liquifloat T FTS20.
 - c. Evoqua Water Technologies, 9G-EF.
 - d. Xylem-Flygt, Model ENM-10.
5. Displacement float level switch:
 - a. B/W, Unifloat.
 - b. Gems Sensors and Controls, Series LS-3.
6. Ultrasonic level switch:
 - a. Siemens Pointek ULS200.

2.04 MANUFACTURED UNITS

- A. As specified in this Section, including Attachment A - ISA Datasheet - Level Measurement: Switches.
- B. Conductivity level switch:
 1. General:
 - a. Probe type conductivity level switches integrating a control relay, control and reference electrode probes as required, and electrode probe holder. Electrode probes shall be rigid stainless steel and probe holder pressure tight.
 - b. All components provided by the same manufacturer.
 2. Element:
 - a. Rigid type:
 - 1) For probe lengths of 6 feet and less, provide Type 316 stainless steel rigid probes.
 - 2) Electrode probe shall be threaded at one end to fit electrode holder threads and insulated with 1/32-inch PVC sheath down to 1 inch from the other end.
 - b. Electrode probe holder.
 - c. Suspended probes:
 - 1) For probe lengths longer than 6 feet, provide wire suspended probes within a protective plastic shield suspended and PVC insulated wires.
 - 2) Provide suitable adapters for fastening upper end to electrode fitting.
 3. Switch: Control relay senses the liquid level by conductance through electrode probes and the process liquid:
 - a. Provide a solid-state general-purpose control relay designed for single level or differential control.
 - b. Electrical connection: One 1/2-inch NPT conduit entry.
 - c. Power supply:
 - 1) As indicated in the datasheets.
 - 2) 24 VDC.
 - 3) 120 VAC.

4. Output:
 - a. Relay outputs:
 - 1) As indicated in the datasheets.
 - 2) SPDT contacts rated 5 amps resistive at 120 VAC.
 - 3) Enclosure:
 - a) As indicated in the datasheets.
 - b) Non-hazardous area:
 - (1) NEMA 4X.
 - 4) Configurable for fail-safe operation.
 5. Components:
 - a. Adjustable time delay on increasing or decreasing level.
- C. Capacitance level switch:
1. Shall be made up of a control relay, mechanically rigid and rugged non-metallic probe and probe housing.
 2. Switch:
 - a. Provide a rigid, non-metallic element.
 - b. Control relay senses the liquid level by capacitance measurement between the electrode probe, the process liquid, and the equipment ground:
 - 1) Power supply:
 - a) As indicated in the datasheets.
 - b) 24 VDC.
 - c) 120 VAC.
 - 2) Outputs:
 - a) Relay outputs:
 - (1) As indicated in the datasheets.
 - (2) 1 Form C contact.
 - (3) Rated at 6 amps at 120 VAC.
 - (4) Programmable for adjustable hysteresis.
 - (5) Configurable for fail-safe operation.
 - c. Electrical connection: One 1/2-inch NPT conduit entry.
 - d. Enclosure:
 - 1) As indicated in the datasheets.
 - 2) Non-hazardous area:
 - a) NEMA 4X.
 - 3) For more information, see Attachment A - ISA Datasheet - Level Measurement: Switches.
- D. Tuning fork level switch:
1. Comprised of a control relay, mechanically rigid fork, and transmitter housing.
 2. Switch: Control relay senses the liquid level by frequency attenuation at the probe fork when immersed.
 - a. Power supply:
 - 1) As indicated in the datasheets.
 - 2) 24 VDC.
 - 3) 120 VAC.
 - b. Outputs:
 - 1) Relay outputs:
 - a) As indicated in the datasheets.
 - b) 1 Form C contact.

- c) 5 amps at 120 VAC.
 - d) Configurable for fail-safe operation.
 - c. Electrical connection: One 1/2-inch NPT conduit entry.
 - d. Enclosure:
 - 1) As indicated in the datasheets.
 - 2) Non-hazardous area:
 - a) NEMA 4X.
- E. Ball float level switch:
 - 1. Encapsulated body with a switch to determine position of float.
 - 2. Outputs:
 - a. Power supply.
 - b. Relay outputs.
 - c. 1 Form C contact.
 - d. Rated at 6 amps at 120 VAC.
 - e. Programmable for adjustable hysteresis.
 - 3. Element:
 - a. Mechanical switch encapsulated in waterproof floating ball of nominal diameter, supported by flexible PVC cable and jacket or heavy neoprene.
 - b. Length of the PVC cable shall be, at a minimum, equal to sump depth plus 5 feet.
 - c. Float: Provide Type 316 stainless steel or polypropylene, maximum 5.5 inches in diameter.
 - d. An operating temperature rating: -4 degrees Fahrenheit to 185 degrees Fahrenheit.
 - e. Mercury switches are not acceptable.
 - f. Suspend ball float and adjust for level setpoint as required.
 - g. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.
 - h. Provide the number of floats per level system as indicated on the Drawings.
 - 4. Switch:
 - a. Power supply:
 - 1) None.
 - b. Outputs:
 - 1) As indicated in the datasheets.
 - 2) Single pole double throw contacts rated 10 amps resistive at 120 VAC.
 - c. Enclosure:
 - 1) As indicated in the datasheets.
 - 2) Non-hazardous area:
 - a) NEMA 4X.
 - 3) For more information, see Attachment A - ISA Datasheet - Level Measurement: Switches.
 - 5. Components:
 - a. Floats shall include Type 316 stainless steel clamp and brackets and 1/4-inch cable to allow testing of the float without entering the basin or wet well.
 - b. Provide strain relief at both ends of the float cable.
 - c. Float anchors:
 - 1) Furnish PVC coated anchor kit with Type 316 stainless steel chain.

- 2) Provide stainless steel shackles and float clamps.
 - 3) Manufacturers: The following or equal:
 - a) Conery Manufacturing, Inc.
- F. Displacement float level switch:
 - 1. Float with a permanent magnet encircles a stationary stem. A hermetically sealed magnetically operated latching reed switch(es) mounted in the stem:
 - a. Mercury switches are not acceptable.
 - 2. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.
 - 3. Switch:
 - a. As indicated in the datasheets.
 - b. Single pole single throw (SPST).
 - 4. Rating:
 - a. As indicated in the datasheets.
 - b. Non-hazardous area:
 - 1) NEMA 4X.
 - 5. Number of floats per level system shall be as indicated on the Drawings.
- G. Ultrasonic level switch:
 - 1. Comprised of a control relay, ultrasonic transducer in the range of 12 to 50 kHz.
 - 2. Switch: Control relay senses the liquid level by frequency attenuation by non-contact ultrasonic transducer. Beam angle is 12 degrees, with a measurement range of 16.4 feet for liquids.
 - 3. Housing material:
 - a. ETFE.
 - b. PVDF.
 - c. Epoxy coated aluminum.
 - d. Power supply:
 - 1) As indicated in the datasheets.
 - 2) 24 VDC.
 - 3) 120 VAC.
 - e. Outputs:
 - 1) As indicated in the datasheets.
 - 2) Relay outputs:
 - a) 2 Form SPDT contacts.
 - b) 5 amps at 250 VAC.
 - c) 100 mA 24 VDC.
 - 3) Configurable for fail-safe operation.
 - f. Electrical connection: One 1/2-inch NPT conduit entry.
 - g. Enclosure:
 - 1) As indicated in the datasheets.
 - 2) Non-hazardous area:
 - a) NEMA 4X.

2.05 ACCESSORIES

- A. Provide sunshades for outdoor installation.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

- A. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.03 CALIBRATION AND TESTING

- A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 SCHEDULES

- A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
 - 1. Instruments may be as indicated on the Drawings, as specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - LEVEL MEASUREMENT: SWITCHES

PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG LSH-111 LE-111	P&ID 00N01	SERVICE LEVEL FLOAT SWITCH HIGH FLUID [*] MEASURING PRINCIPLE FLOAT SET POINT 2.5 FT MOUNTING INTEGRAL TYPICAL DETAILS [*] SURGE PROTECTION NO	HAZARDOUS APP N/A ELEM. ENC. CLASS NEMA 4X ELEM. MATERIAL MFR. STD. SWITCH ENCL. CLASS NEMA 4X ENCL. MATERIAL MFR. STD.	POWER [*] POWER LOCATION LOOP OUTPUT RELAY RELAY FORM SPDT PLC PLC-DIW1
TAG LSH-112 LE-112	P&ID 00N01	SERVICE LEVEL FLOAT SWITCH HIGH FLUID [*] MEASURING PRINCIPLE FLOAT SET POINT 2.5 FT MOUNTING INTEGRAL TYPICAL DETAILS [*] SURGE PROTECTION NO	HAZARDOUS APP N/A ELEM. ENC. CLASS NEMA 4X ELEM. MATERIAL MFR. STD. SWITCH ENCL. CLASS NEMA 4X ENCL. MATERIAL MFR. STD.	POWER [*] POWER LOCATION LOOP OUTPUT RELAY RELAY FORM SPDT PLC PLC-DIW2
TAG LSH-113 LE-113	P&ID 00N02	SERVICE LEVEL FLOAT SWITCH HIGH FLUID [*] MEASURING PRINCIPLE FLOAT SET POINT 2.5 FT MOUNTING INTEGRAL TYPICAL DETAILS [*] SURGE PROTECTION NO	HAZARDOUS APP N/A ELEM. ENC. CLASS NEMA 4X ELEM. MATERIAL MFR. STD. SWITCH ENCL. CLASS NEMA 4X ENCL. MATERIAL MFR. STD.	POWER [*] POWER LOCATION LOOP OUTPUT RELAY RELAY FORM SPDT PLC PLC-DIW1

SECTION 40_73_23

PRESSURE/VACUUM MEASUREMENT: DIRECT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Pressure transmitters and indicators.
- B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. Lower range value (LRV): Lowest pressure that the pressure transmitter is capable of measuring.
 - 2. Upper range value (URV): Highest pressure that the pressure transmitter is capable of measuring.
 - 3. Calibrated range: The range that the pressure transmitter is configured to measure. The low end of the calibrated range must be greater than the LRV of the transmitter. The high end of the calibrated range must be less than or equal to the URV. The calibrated range corresponds to the flow signal sent from the transmitter.

1.04 SUBMITTALS

- A. Furnish submittals as specified in Sections 01_33_00 - Submittal Procedures and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

- B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.
- D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Project environmental conditions as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
 - 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, humidity, and process and ambient temperatures.

1.08 WARRANTY

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

- A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Emerson, Rosemount 3051 Series.
 - 2. Emerson, Rosemount 2051 Series with High performance option
 - 3. Yokogawa, EJA Series.

4. ABB, 266 Series.
5. Endress & Hauser, Cerabar S Series.

2.02 MANUFACTURED UNITS

- A. As specified in this Section including Attachment A - ISA Data Sheet - Pressure/Vacuum Measurement: Direct.
- B. Pressure transmitters - direct:
 1. General:
 - a. Pressure transmitter assembly shall include a diaphragm type pressure transducer and microprocessor based transmitter for measurement of gauge, vacuum, or absolute pressure.
 2. Performance requirements:
 - a. Maximum ratio of total instrument range to calibrated span: 10 to 1.
 - b. Accuracy:
 - 1) Reference accuracy: Plus or minus 0.075 percent of calibrated span, including effects of hysteresis, nonlinearity, and repeatability.
 - 2) Total performance accuracy: Plus or minus 0.30 percent of calibrated span, including reference accuracy effects, static pressure and ambient temperature effects.
 - 3) Stability: Plus or minus 0.15 percent of upper range limit over 5 years.
 3. Element:
 - a. Diaphragm type transducer integral to pressure transmitter.
 - b. Diaphragm material: Stainless steel or ceramic.
 - c. Process material compatibility:
 - 1) Verify all material compatibilities with the instrument manufacturer.
 - d. Process connection: As specified in Attachment A - ISA Data Sheet - Pressure/Vacuum Measurement: Direct.
 4. Transmitter:
 - a. Power supply:
 - 1) 24 VDC - 2 wire loop powered.
 - 2) Power consumption: 3 VA maximum.
 - b. Outputs:
 - 1) Isolated 4-20mA DC with HART communication protocol.
 - c. Provided with electronic microprocessor.
 - d. Adjustments: Adjustable electronic zero and span, with elevated or suppressed zero as required by application. Adjustment shall be possible without mechanical fulcrum points or handheld configurator.
 - e. Local display:
 - 1) 5-digit LCD.
 - 2) Scaled in engineering units.
 - f. Enclosure:
 - 1) Non-hazardous area:
 - a) NEMA Type 4X.
 - 2) Class I Division 1 area:
 - a) Explosion-proof/Class I Division 1 rated.
 - b) NEMA 4X with intrinsic safe circuits.

- 3) Class I Division 2 area:
 - a) Explosion-proof/Class I Division 1 rated.
 - b) Class I Division 2 rated.
 - c) NEMA 4X with intrinsic safe circuits.
- 4) For more information, see Attachment A - ISA Data Sheet - Pressure/Vacuum Measurement: Direct.
- g. Over range protection: To maximum process line pressure.
- h. Conduit: 1/2-inch male NPT.
- 5. Components:
 - a. Transmitter mounting:
 - 1) As specified in Attachment A - ISA Data Sheet - Pressure/Vacuum Measurement: Direct.
 - 2) Provide all necessary hardware for transmitter mounting.

2.03 ACCESSORIES

- A. Provide valve manifolds as specified in Section 40_73_64 - Pressure/Vacuum Measurement: Instrument Valves:
 - 1. Mount valve manifold integrally to the transmitter.
 - 2. Valve manifold and transmitter shall be assembled by Manufacturer and shipped as an assembly.
 - 3. Provide remote or integral diaphragm seals as specified in Attachment A - ISA Data Sheet - Pressure/Vacuum Measurement: Direct and in Section 40_73_63 - Pressure/Vacuum Measurement: Diaphragm and Annular Seals.
- B. Provide sunshades for outdoor installations.
- C. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.04 SOURCE QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
 - 1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.
- C. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
 - 1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

- A. As specified in Section 40_80_01 - - Commissioning for Instrumentation and Controls.

3.06 CLEANING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES

- A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
 - 1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATA SHEET - PRESSURE/VACUUM MEASUREMENT: DIRECT

Pressure/Vacuum Measurement: Direct

40_73_23-6

7126110

November 2025

pw://Carollo/Documents/Client/FL/Collier County/7126110/Specifications/40_73_23 (Bid Set)

PROJECT INFORMATION

PLANT
PROJECT 7126I10

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG PIT-111 (PE-111)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 00N01
SERVICE PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT
PLC PLC-DIW1
TYPICAL DETAILS [*]

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES [*]

FLUID

FLUID [*]
TEMPERATURE [*]

PRESSURE RANGE 0-150 PSIG

ELEMENT

ELEMENT TAG NO. PE-111
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A

SEAL TYPE DIAPHRAGM
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-111
MOUNTING INT
ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE [*]
OUTPUT 4-20 MA
SURGE PROTECTION YES

NOTES

[*]

PROJECT INFORMATION

PLANT
PROJECT 7126I10

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG PIT-112 (PE-112)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 00N01
SERVICE PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT
PLC PLC-DIW2
TYPICAL DETAILS [*]

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES [*]

FLUID

FLUID [*]
TEMPERATURE [*]

PRESSURE RANGE 0-150 PSIG

ELEMENT

ELEMENT TAG NO. PE-112
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A

SEAL TYPE DIAPHRAGM
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-112
MOUNTING INT
ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE [*]
OUTPUT 4-20 MA
SURGE PROTECTION YES

NOTES

[*]

PROJECT INFORMATION

PLANT
PROJECT 7126I10

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG PIT-113 (PE-113)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 00N02
SERVICE PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT
PLC PLC-DIW1
TYPICAL DETAILS [*]

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES [*]

FLUID

FLUID [*]
TEMPERATURE [*]

PRESSURE RANGE 0-200 PSIG

ELEMENT

ELEMENT TAG NO. PE-113
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A

SEAL TYPE DIAPHRAGM
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-113
MOUNTING INT
ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE [*]
OUTPUT 4-20 MA
SURGE PROTECTION YES

NOTES

[*]

PROJECT INFORMATION

PLANT
PROJECT 7126I10

CUSTOMER COLLIER COUNTY
LOCATION

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG PIT-114 (PE-114)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 00N02
SERVICE PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT
PLC PLC-DIW1
TYPICAL DETAILS [*]

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES [*]

FLUID

FLUID [*]
TEMPERATURE [*]

PRESSURE RANGE ____-____ PSIG

ELEMENT

ELEMENT TAG NO. PE-114
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A

SEAL TYPE DIAPHRAGM
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-114
MOUNTING INT
ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE [*]
OUTPUT 4-20 MA
SURGE PROTECTION YES

NOTES

[*]

SECTION 40_73_36

PRESSURE/VACUUM MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Pressure/vacuum switches.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

- A. Furnish Submittals as specified in Section 01_33_00 - Submittal Procedures and Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Product data:
 - 1. Accessories.

1.04 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

- A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide instruments specified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

- A. Mechanical type pressure switch: One of the following or equal:
 - 1. ASCO, S-Series.
 - 2. Ashcroft, B Series.
 - 3. United Electric, Controls Series.
- B. Electronic type pressure switch: One of the following or equal:
 - 1. Ashcroft, N Series.
 - 2. United Electric, Series One.

2.04 MANUFACTURED UNITS

- A. As specified in this Section, including Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Switches.
- B. Mechanical type pressure switches:
 - 1. General:
 - a. Diaphragm or diaphragm-sealed piston type.
 - 2. Performance requirements:
 - a. Pressure range:
 - 1) As indicated in the datasheets.

- b. Accuracy:
 - 1) Within 1.0 percent of range.
- c. Repeatability:
 - 1) Within 1.0 percent of range.
- 3. Element:
 - a. Type: Diaphragm, diaphragm-sealed piston, or Bourdon® tube.
 - b. Overpressure:
 - 1) Minimum 130 percent of maximum range pressure without damage to switch or sensing element.
 - 2) Minimum 400 percent of nominal range without leakage or rupture.
 - c. Sensing element shall not require ambient temperature compensation.
 - d. Wetted materials:
 - 1) As indicated in the datasheets.
 - 2) Stainless steel.
 - e. Setpoint:
 - 1) As indicated in the datasheets.
 - 2) Single

Switch shall activate at setpoint on increasing pressure for high-pressure alarm applications and on decreasing pressure for low-pressure alarm applications.

- f. Deadband:
 - As indicated in the datasheets.
 - 1) Fixed
- g. Switch elements:
 - 1) As indicated in the datasheets.
 - a) Single-pole double-throw (SPDT)
 - 1) As indicated in the datasheets.
 - 2) Rated at 5 A, 125/250 VAC.
 - 1) Resets:
 - a) As indicated in the datasheets.
 - b) Automatic
- h. Enclosure: Epoxy coated:
 - 1) As indicated in the datasheets.
 - 2) Non-hazardous area:
 - a) NEMA Type 4X
- i. Switch mounting:
 - 1) As indicated in the datasheets.
 - 2) Process connection: 1/2-inch NPT.

- 4. Components:
 - a. Provide necessary hardware for pressure switch mounting.

C. Electronic indicating type pressure switches:

- 1. General:
 - a. Pressure switch shall utilize ceramic or polysilicon thin film pressure transducer.
- 2. Performance requirements:
 - a. Pressure range:
 - 1) As specified in datasheets.
 - b. Accuracy:
 - 1) Within 1.0 percent of range.

- c. Repeatability:
 - 1) Within 1.0 percent of range.
- 3. Element:
 - a. Type: Ceramic or polysilicon thin film.
 - b. Overpressure:
 - 1) Minimum 130 percent of maximum range pressure without damage to switch or sensing element.
 - 2) Minimum 400 percent of nominal range without leakage or rupture.
 - c. Sensing element shall not require ambient temperature compensation.
 - d. Wetted materials:
 - 1) As indicated in the datasheets.
 - 2) Stainless steel.
- 4. Transmitter:
 - a. Setpoint:
 - 1) As indicated in the datasheets.
 - 2) Single
 - 3) Switch shall activate at setpoint on increasing pressure for high-pressure alarm applications and on decreasing pressure for low-pressure alarm applications.
 - b. Deadband:
 - 1) Fixed
 - c. Switch elements:
 - 1) Snap acting.
 - a) As indicated in the datasheets.
 - b) Single-pole double-throw (SPDT)
 - c) 2 single-pole double-throw (SPDT)
 - 2) Resets:
 - a) Automatic
 - d. Enclosure: Epoxy-coated.
 - 1) As indicated in the datasheets.
 - 2) Non-hazardous area:
 - a) NEMA Type 4X.
 - 3) For more information, see Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Switches.
 - e. Local display:
 - 1) 4-digit LCD or LED.
 - 2) Scaled in engineering units.
 - f. Switch mounting:
 - 1) Process connection: 1/2-inch NPT.
 - g. Power supply:
 - 1) As indicated in the datasheets.
 - 2) 120 VAC
 - 3) 24 VDC
 - h. Outputs:
 - 1) As indicated in the datasheets.
 - 2) Isolated 4 to 20 mA DC with HART communication protocol.
 - i. Relay outputs:
 - 1) As indicated in the datasheets.
 - j. Rated 5 A at 120 VAC.

- k. Components:
 - 1) Provide necessary hardware for pressure switch mounting.

2.05 ACCESSORIES

- A. Pulsation dampeners and snubbers:
 - 1. Provide with each pressure switch installed on discharge of positive displacement type pump.
 - 2. Materials: Stainless steel.
 - 3. Mount integrally to the pressure switch.
 - 4. Connection: 1/2-inch NPT.
- B. Provide diaphragm seals as specified in the datasheets or as indicated on the Drawings and as specified in Section 40_73_63 - Pressure/Vacuum Measurement: Diaphragm and Annular Seals:
 - 1. Diaphragm seal and pressure switch shall be assembled by the manufacturer and shipped as an assembly.
- C. Furnish instrument isolation as indicated in the datasheets and specified in Section 40_73_64 - Pressure/Vacuum Measurement: Instrument Valves:
 - 1. Mount isolation device integrally to the instrument.
 - 2. Isolation device and instrument shall be assembled by the manufacturer and shipped as an assembly.
- D. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

- A. Factory calibrate each instrument with a minimum 3-point calibration or according to the manufacturer's standard at a facility that is traceable to the NIST.
 - 1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the Project Site.
- B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 CALIBRATION AND TESTING

- A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.04 ADJUSTING

- A. Verify factory calibration of instruments in accordance with the manufacturer's instructions:
 - 1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.05 SCHEDULES

- A. The provided information does not necessarily include all required instruments. Provide all instruments specified in the Contract Documents:
 - 1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - PRESSURE/VACUUM MEASUREMENT: SWITCHES

PROJECT INFORMATION

PLANT
PROJECT 7126110

CUSTOMER COLLIER COUNTY
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PRESSURE SWITCH			
PSH-101	00N01		FLUID [*]	HAZARDOUS APP N/A	POWER [*]	
PE-101			FLUID TEMPERATURE N/A	ELEM. ENCL. CLASS NEMA 4X	POWER LOCATION LOOP	
			MEASURING PRINCIPLE PRESSURE	ELEMENT MATERIAL MFR. STD.	OUTPUT RELAY	
			SET POINT ____ - ____ PSIG	SWITCH ENCL. CLASS NEMA 4X	RELAY FORM SPDT	
			ADJUSTABLE RANGE [*]	ENCL. MATERIAL MFR. STD.	PLC PLC-DIW1	
			TYPICAL DETAILS NP503	SURGE PROTECTION NO	MANUAL RESET NO	
			CONN. MOUNTING BOTTOM	BOTT. HOUSING MAT. MFR. STD.	SEAL TYPE DIAPHRAGM	
			CONNECTON TYPE M-NPT	INSTRUMENT VALVES [*]	DIAPHRAGM/WET MAT MFR. STD.	
TAG	P&ID	SERVICE	PRESSURE SWITCH			
PSL-102	00N01		FLUID [*]	HAZARDOUS APP N/A	POWER [*]	
PE-102			FLUID TEMPERATURE N/A	ELEM. ENCL. CLASS NEMA 4X	POWER LOCATION LOOP	
			MEASURING PRINCIPLE PRESSURE	ELEMENT MATERIAL MFR. STD.	OUTPUT RELAY	
			SET POINT ____ - ____ PSIG	SWITCH ENCL. CLASS NEMA 4X	RELAY FORM SPDT	
			ADJUSTABLE RANGE [*]	ENCL. MATERIAL MFR. STD.	PLC PLC-DIW1	
			TYPICAL DETAILS NP503	SURGE PROTECTION NO	MANUAL RESET NO	
			CONN. MOUNTING BOTTOM	BOTT. HOUSING MAT. MFR. STD.	SEAL TYPE DIAPHRAGM	
			CONNECTON TYPE M-NPT	INSTRUMENT VALVES [*]	DIAPHRAGM/WET MAT MFR. STD.	
TAG	P&ID	SERVICE	PRESSURE SWITCH			
PSH-103	00N01		FLUID [*]	HAZARDOUS APP N/A	POWER [*]	
PE-103			FLUID TEMPERATURE N/A	ELEM. ENCL. CLASS NEMA 4X	POWER LOCATION LOOP	
			MEASURING PRINCIPLE PRESSURE	ELEMENT MATERIAL MFR. STD.	OUTPUT RELAY	
			SET POINT ____ - ____ PSIG	SWITCH ENCL. CLASS NEMA 4X	RELAY FORM SPDT	
			ADJUSTABLE RANGE [*]	ENCL. MATERIAL MFR. STD.	PLC PLC-DIW2	
			TYPICAL DETAILS NP503	SURGE PROTECTION NO	MANUAL RESET NO	
			CONN. MOUNTING BOTTOM	BOTT. HOUSING MAT. MFR. STD.	SEAL TYPE DIAPHRAGM	
			CONNECTON TYPE M-NPT	INSTRUMENT VALVES [*]	DIAPHRAGM/WET MAT MFR. STD.	

PROJECT INFORMATION

PLANT
PROJECT 7126I10

CUSTOMER COLLIER COUNTY
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PRESSURE SWITCH		
PSL-104	00N01		FLUID [*]	HAZARDOUS APP N/A	POWER [*]
PE-104			FLUID TEMPERATURE N/A	ELEM. ENCL. CLASS NEMA 4X	POWER LOCATION LOOP
			MEASURING PRINCIPLE PRESSURE	ELEMENT MATERIAL MFR. STD.	OUTPUT RELAY
			SET POINT ____ - ____ PSIG	SWITCH ENCL. CLASS NEMA 4X	RELAY FORM SPDT
			ADJUSTABLE RANGE [*]	ENCL. MATERIAL MFR. STD.	PLC PLC-DIW2
			TYPICAL DETAILS [*]	SURGE PROTECTION NO	MANUAL RESET NO
			CONN. MOUNTING BOTTOM	BOTT. HOUSING MAT. MFR. STD.	SEAL TYPE DIAPHRAGM
			CONNECTON TYPE M-NPT	INSTRUMENT VALVES [*]	DIAPHRAGM/WET MAT MFR. STD.

SECTION 40_73_63

PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM AND ANNULAR SEALS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Diaphragm seals.
 - 2. Annular seals.
- B. Provide all seals identified in the Contract Documents.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

- A. Furnish submittals as specified in Sections 01_33_00 - Submittal Procedures and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Additional requirements:
 - 1. Product data:
 - a. Manufacturer's installation instructions.
 - b. Seal type.
 - c. Body materials.
 - d. Diaphragm material.
 - e. Fill fluid type.
 - f. Seal size.
 - g. Options.
 - h. Process connection.

1.05 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify the compatibility with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

- 2. Physical conditions:
 - a. Installation and mounting requirements.
 - b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

- A. As specified in Section 01_81_50 - Design Criteria.

1.08 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

- A. Provide spare annular seal for every size indicated in the project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Diaphragm seals:
 - 1. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch gauge: One of the following or equal:
 - a. Ashcroft:
 - 1) Flushing connection: Type 741.
 - 2) Without flushing connection: Type 740.
 - b. Mansfield and Green:
 - 1) Flushing connection: Type SGT.
 - 2) Without flushing connection: Type SBT.
 - c. Wika, Type L990.40.
 - d. Emerson, Rosemount.
 - 2. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures greater than or equal to 15 pounds per square inch gauge: One of the following or equal:
 - a. Ashcroft:
 - 1) Flushing connection: Type 201.
 - 2) Without flushing connection: Type 200.

- b. Mansfield and Green:
 - 1) Flushing connection: Type SG.
 - 2) Without flushing connection: Type SB.
 - c. Wika:
 - 1) Type L990.10.
 - B. Annular seals:
 - 1. One of the following or equal:
 - a. Ashcroft, Wafer Isolation Ring.
 - b. Onyx Valve.

2.02 MANUFACTURED UNITS

- A. Diaphragm seals:
 - 1. General:
 - a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
 - 2. Requirements:
 - a. Seal type:
 - 1) Metallic diaphragm: Welded to upper housing.
 - 2) Elastomer diaphragm: Bonded to upper housing.
 - b. Process connection: 1 inch NPT.
 - c. Instrument connection: 1/2 inch NPT.
 - d. Material Construction: Type 316 Stainless Steel.
 - e. Provide 1/4-inch flushing connection in diaphragm lower housing or provide flushing ring.
 - f. Flush port plug: Same material of construction as diaphragm lower housing.
 - g. Provide fill/bleed connection.
 - h. Mounting: As indicated in the Contract Documents.
 - i. Provide Type 316 stainless steel armored capillary for all remote installations.
 - j. Nuts and bolts: Type 316 stainless steel.
 - k. Materials of construction:
 - 1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch:
 - a) Diaphragm: Type 316 stainless steel.
 - b) Lower housing: Type 316 stainless steel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicone oil.
 - 2) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures greater than 15 pounds per square inch:
 - a) Diaphragm: Type 316 stainless steel.
 - b) Lower housing: Type 316 stainless steel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicone oil.
 - 3) Chlorine:
 - a) Diaphragm: Tantalum.
 - b) Lower housing: Hastelloy C.

- c) Upper housing: Manufacturer's standard.
- d) Fill fluid: Halocarbon.
- 4) Ferric chloride:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: PVC or titanium.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicone oil.
- 5) Fluorosilicic acid:
 - a) Diaphragm: Viton™.
 - b) Lower housing: PVC.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicone oil.
- 6) Hydrochloric acid:
 - a) Diaphragm: PVDF or tantalum.
 - b) Lower housing: Hastelloy B2.
 - c) Upper housing: Manufacturer's Standard.
 - d) Fill fluid: Fluorolube.
- 7) Ozone:
 - a) Diaphragm: Type 316 stainless steel.
 - b) Lower housing: Type 316 stainless steel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
- 8) Potassium permanganate:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: PVDF or titanium.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
- 9) Sodium permanganate:
 - a) Diaphragm: PTFE.
 - b) Lower housing: PVDF.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Halocarbon.
- 10) Sodium bisulfite:
 - a) Diaphragm: Tantalum.
 - b) Lower housing: Titanium.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicone oil.
- 11) Sodium hydroxide:
 - a) Diaphragm: Monel.
 - b) Lower housing: Monel.
 - c) Upper housing: Manufacturer's standard.
 - d) Fill fluid: Silicone oil.
- 12) Sodium hypochlorite:
 - a) Diaphragm: Tantalum.
 - b) Lower Housing: Titanium.
 - c) Upper Housing: Manufacturer's standard.
 - d) Fill Fluid: Halocarbon.
- 13) Sulfur dioxide:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: PVDF or titanium.

- c) Upper housing: Manufacturer's standard.
- d) Fill fluid: Halocarbon.
- 14) Sulfuric acid:
 - a) Diaphragm: PTFE or tantalum.
 - b) Lower housing: Hastelloy B2.
 - c) Upper housing: Manufacturer's Standard.
 - d) Fill fluid: Halocarbon.
- 15) Engineer's approval.

2.03 ACCESSORIES (NOT USED)

2.04 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation System.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.
- C. Do not use Teflon™ thread seal tape on pressure instruments with silicone oil fill fluid.

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 ADJUSTING (NOT USED)

3.06 CLEANING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING (NOT USED)

3.08 PROTECTION (NOT USED)

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_73_64

PRESSURE/VACUUM MEASUREMENT: INSTRUMENT VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Valve manifolds and instrument valves.
- B. Provide all valves identified in the Contract Documents.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

- A. Furnish submittals as specified in Sections 01_33_00 - Submittal Procedures and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Additional requirements:
 - 1. Product data:
 - a. Valve type.
 - b. Body material.
 - c. Size.
 - d. Options.
 - 2. Shop drawings:
 - a. Mounting details for all manifold valves.

1.05 QUALITY ASSURANCE

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Examine the complete set of Contract Documents and verify that the valves are compatible with the installed conditions including:
 - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
 - 2. Physical conditions:
 - a. Installation and mounting requirements.

- b. Location within the process.
 - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the valve manufacturer's recommendations or specifications.
- D. Provide valves manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.07 PROJECT OR SITE CONDITIONS

- A. Project environmental conditions as specified in Section 01_81_50 - Design Criteria.
 - 1. Provide valves suitable for the installed site conditions including, but not limited to, material compatibility, process, and ambient temperatures.

1.08 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

1.09 MAINTENANCE

- A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Valve manifold:
 - 1. One of the following or equal:
 - a. Anderson Greenwood.
 - b. Hex Valve.
 - c. Noshok.
 - d. Emerson, Rosemount.
- B. Block and bleed valve:
 - 1. One of the following or equal:
 - a. Anderson Greenwood.
 - b. Hex Valve.

- C. Gauge valve:
 - 1. One of the following or equal:
 - a. Anderson Greenwood.
 - b. Hex Valve.
- D. Level sensor isolation valve:
 - 1. One of the following or equal:
 - a. Indu-Tech, Level Sensor Isolation Valve.
 - b. DeZURIK, Level Sensor Isolation Valve.
 - c. Tyco, Rovalve Isolation Knife Gate Valve.

2.02 MANUFACTURED UNITS

- A. Valve manifolds:
 - 1. General:
 - a. Provide 2-valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds as indicated on the Drawings.
 - b. Valve manifolds shall have one piece bonnet with a metal to metal seal to the valve body below the bonnet threads.
 - 2. Requirements:
 - a. Bonnet lock pin to prevent accidental loosening.
 - b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
 - c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - d. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
 - e. Manifold valves shall allow for direct or remote instrument mounting.
 - f. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.
 - g. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) O-Ring: Teflon™.
 - h. 2-Valve manifolds:
 - 1) 1 isolation valve and 1 drain/vent and calibration valve.
 - i. 3-Valve manifolds:
 - 1) 2 isolation valves and 1 equalizing valve for differential pressure applications.
 - 2) Plugged vent connections used for vent/drain or calibration.
 - j. Blowdown 5-valve manifold:
 - 1) 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
 - k. Metering 5-valve manifold:
 - 1) 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.
- B. Block and bleed valves:
 - 1. General:
 - a. Valve shall provide process isolation and venting/draining capabilities.
 - b. Gas leak tested metal-to-metal hard seat design for hard seat valves.

- c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - d. Valve shall not be used with fluids with high solids content, such as raw wastewater or sludge.
 - 2. Requirements:
 - a. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) O-Ring: Teflon™.
- C. Gauge valves:
- 1. General:
 - a. Valve shall provide process isolation from pressure instrument.
 - b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
 - c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - 2. Requirements:
 - a. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) O-Ring: Teflon™.
- D. Level sensor isolation valves:
- 1. General:
 - a. Valve shall provide process isolation from level diaphragm.
 - b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
 - c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
 - 2. Requirements:
 - a. Materials of construction:
 - 1) Body material: Type 316 stainless steel.
 - 2) Flange diameter size: 3 inches.

2.03 ACCESSORIES

- A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.
- B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

2.04 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the installation location and verify it will work properly when installed.
 - 1. Notify the Engineer promptly if any installation condition does not meet the manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of all valves.

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 ADJUSTING

- A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.06 CLEANING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING (NOT USED)

3.08 PROTECTION (NOT USED)

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_80_01

COMMISSIONING FOR INSTRUMENTATION AND CONTROLS

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ATTACHMENT E – ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST

ATTACHMENT F - CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Testing requirements that apply to process control and instrumentation systems for the entire Project.

1.02 REFERENCES

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Electronics Industries Alliance (EIA).
- C. Telecommunications Industry Association (TIA).

1.03 DEFINITIONS

- A. As specified in Sections 01_75_17 - Commissioning and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Specific definitions:
 - 1. Complete End-to-End Testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
 - 2. Loop Validation Tests - Signals are tested from the field device to the PLC.
 - 3. Platform Testing: Testing of the PLC and SCADA/HMI at the manufacturer's or programmer's shop to demonstrate the program's functionality based upon specified and designed control requirements.
 - 4. PTO: Profibus Trade Organization.
 - 5. Permanent Link: The fixed portion of cabling installed between an equipment outlet and its immediate distributor or between 2 distributors.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 01_33_00 - Submittal Procedures.
- B. General:
 - 1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- C. Overall test plan:
 - 1. Develop the PCIS system test submittals in consultation and cooperation with all applicable subcontractors.
 - 2. Develop and submit an overall testing plan for the PCIS. The overall test plan to be reviewed and approved by the Engineer before detailed test plans, procedures, and forms will be reviewed.

3. Describe the test phases as they apply specifically to this Project and each process system.
 4. Provide a preliminary testing schedule to show the sequence of tests and commissioning as they apply to each process system and each PLC.
 5. Provide a description of factory tests. Describe what equipment will be included, what testing equipment will be used, and the simulator that will be used.
 6. Provide examples of proposed forms and checklists.
- D. Test procedures:
1. Develop and submit detailed test procedures to show that the integrated SCADA system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
 2. Provide a statement of test objectives for each test.
 3. Prepare specific procedures for each process system.
 4. Describe sequentially the steps to be followed in verifying the correct operation of each process system, including all features described in the loop descriptions, control strategies, and shown in the P&IDs. Implied or generic test procedures are not acceptable.
 5. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), and how the testing equipment will be used.
 6. Describe the expected role of the Engineer, as well as any requirements for assistance from Owner's staff.
 7. Provide the forms and checklists to be used.
- E. Test forms:
1. Submit completed calibration forms, test forms, and checklists.
 - a. Test forms shall include the detailed test procedures or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
 - b. Every page of each test form shall include project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (Engineer and Owner) witnessing the test.
 - c. Sample test forms at the end of this Section show the minimum required content.
 - 1) The sample test forms have not been customized for this Project.
 - 2) Contractor shall develop and submit test forms customized for the Project and meeting the specified test and submittal requirements.
- F. FAT procedure additional minimal requirements:
1. Prepare and submit a FAT procedure which includes:
 - a. Control system testing block diagram.
 - b. Estimated test duration.

- G. Details on the simulator construction, components, and operation. Testing binders:
 - 1. Sub-system to be tested, provide and submit a test binder containing all test procedures and individual test forms for the test. References to other documents for test procedures and requirements are not acceptable.
 - 2. Fill out in advance headings and all other information known before the test.
 - 3. Include applicable test plan information, as well as a list of all test prerequisites, test personnel, and equipment.
 - 4. Include or list reference material and provide separately at the time of the test.
 - 5. Record test results and verify that all test requirements and conditions have been met.
- H. Test reports:
 - 1. At the conclusion of each test, submit a complete test report, including all test results and certifications.
 - 2. Include all completed test binders, forms, and checklists.
 - 3. Submission, review, and acceptance of each test report is required before the start of the sub-system.

1.06 QUALITY ASSURANCE

- A. Test personnel:
 - 1. Furnish qualified technical personnel to perform all calibration, testing, and verification. The test personnel are required to be familiar with this Project and the equipment, software, and systems before being assigned to the test program.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
- B. Installation supervision:
 - 1. Provide as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 COMMISSIONING

- A. Commissioning as specified in Section 01_75_17 - Commissioning.
- B. Testing and training phase:
 - 1. Source testing:
 - a. Manufacturer services: Provide as specified in the table below.

Section Number	Section Title	Source Testing (Witnessed or Non-Witnessed)
40_61_15 - Control Strategies	Control Strategies	Witnessed
40_67_01 - Control Systems - Panels, Enclosures, and Panel Components.	Control Systems - Panels, Enclosures, and Panel Components	Witnessed
40_80_01 – Commissioning for Instrumentation and Controls	Commissioning for Instrumentation and Controls	Witnessed

- b. Prerequisite requirements:
 - 1) Engineer approval of the hardware and equipment source testing submittal, Manufacturer Certificate of Source Testing, is required before proceeding to Preliminary FAT.

- c. Preliminary FAT (Pre-FAT):
 - 1) The purpose of the Pre-FAT is to provide assurance that the HMI/SCADA system is ready for the full, witnessed FAT, in terms of both stability and functionality.
 - a) Debugging of software and troubleshooting of hardware shall occur during and before the pre-FAT, not during the FAT.
 - b) Contractor shall fully test the HMI/SCADA system and fix all deficiencies found before the FAT.
 - 2) Conduct utilizing test procedures approved by Engineer
 - 3) Owner shall have the right to witness any or all of the Pre-FAT testing and shall be notified in writing 20 days before the start of the pre-FAT.
 - 4) Submit a letter, signed by the Contractor's project manager or company officer, certifying that integrated system hardware and software has been tested and confirmed to be fully operational and in compliance with the requirements specified in the Contract Documents and is fully ready for the full, witnessed FAT.
 - a) Attach the completed pre-FAT test forms, signed by the Contractor's staff.
 - 5) Engineer approval of the pre-FAT submittal is required before proceeding to FAT.
- d. FAT hardware and communications testing:
 - 1) Perform tests to show that the integrated system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
 - 2) The complete PCIS system including operator stations, servers, network equipment, printers, PCMs, PLCs, RTUs, LCPs, CCS, peripherals, communications equipment, and other HMI/SCADA equipment, shall be assembled, connected, and software loaded for a fully functional FAT of the integrated system.
 - 3) For any fault tolerant networks such as ring topology networks, disconnect each segment of the network individually to demonstrate proper failover and alarming at the HMI.
 - 4) Testing simulation:
 - a) Inputs and outputs shall be simulated and proper control and system operation shall be validated.
 - b) Whenever supplied equipment is available, such as devices internal to the control panel, test input and output signals using the equipment. Simulation is not acceptable.
 - c) FAT shall make use of simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, which shall be connected to the I/O points within the HMI/SCADA system.
 - (1) The use of jumper wires, terminal block mounted pilot lights, and loose meters to act as or supply the functionality of a simulator shall not be allowed.

- (2) The simulator may consist of a PLC, operating under a HMI/SCADA software package, or other approved software that has its I/O points wired to PLC's I/O points.
 - (3) Software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.
- 5) Additional source tests are specified in other sections of the Instrumentation and Control Specifications.
- 6) Owner shall have the right to witness any or all of the FAT testing and shall be notified in writing 20 days before the start of the FAT.
- 7) Verify communications between the hardware and the programmer's software comply with specified requirements.
 - a) For systems that contain RTUs or remote communications with other devices, the complete communications system must be factory tested, including actual interfacing with telephone company equipment and/or the actual radios used for radio based telemetry systems.
- 8) Panel inspections:
 - a) Engineer will inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the accepted shop drawings.
 - (1) Inspection to include, as a minimum: Layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.
 - b) Inspection forms:
 - (1) Provide panel inspection forms as part of the FAT procedures submittal.
 - (2) A sample FAT control panel form has been provided at the end of this Section.
- 9) I/O test:
 - a) Engineer will verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including all operator interface devices.
 - b) Test methodology:
 - (1) Discrete inputs:
 - (a) Apply appropriate input from simulator at panel terminal, observe input card indicator, observe data value at each indicated data address, and observe data received at field wiring terminals or operator interface screen.
 - (2) Discrete outputs:
 - (a) Issue commands from operator interface screen or PLC, verify output card indicator light, and measure response at field wiring terminals or multimeter.
 - (3) Analog inputs:
 - (a) Apply appropriate analog input signal at panel terminals on simulator, observe data value at each indicated data address, and observe data properly

- received at field wiring terminals or operator interface screen.
- (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.
- (4) Analog outputs:
 - (a) Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at field wiring terminals or multimeter.
 - (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.
- c) Test forms to include, but not be limited to the following data:
 - (1) PLC and panel number.
 - (2) I/O type.
 - (3) I/O tag name.
 - (4) Rack/slot/number of I/O point.
 - (5) Check-off for correct response for each I/O point.
 - (6) Comments field.
 - (7) Initials of individual performing test.
 - (8) Date test was performed.
 - (9) Witness signature lines.
- 10) System configuration test:
 - a) Demonstrate and test the setup and configuration of operator stations, servers, development stations, and peripherals.
 - b) Demonstrate utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
 - c) Demonstrate the proper operation of peripheral hardware.
 - d) Demonstrate general HMI/SCADA functions.
 - e) Demonstrate proper operation of log-on and other security access functions.
 - f) Demonstrate the proper operation of all historical data storage, trend, display, backup, and report functions.
 - g) Test automatic fail over of redundant equipment.
 - h) Demonstrate the proper operation of the alarm display and acknowledgement functions.
 - i) For any fault tolerant networks, such as ring topology networks, disconnect each segment of the network individually to demonstrate proper failover and alarming.
 - j) Test forms:
 - (1) For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
 - (2) List the specific tests and steps to be conducted.
 - (3) For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
 - (a) Include signature and date lines.
- 11) Engineer approval of the FAT Communication Testing activities is required before proceeding to FAT Platform Testing.

- e. FAT Platform Testing - Control logic test:
 - 1) Verify the PLC, HMI and SCADA, provides monitoring and control functionality based upon specified and designed control requirements.
 - 2) Testing requirements:
 - a) Demonstrate each function described in the Control Strategies.
 - b) Demonstrate in detail how each function operates under a variety of operating scenarios.
 - (1) Test to verify the application of each general control strategy function to each specific control strategy or loop description.
 - c) Demonstrate the proper operation of the programming and configuration for each control strategy or loop description.
 - (1) Test each strategy or loop description on a sentence by sentence and function by function basis.
 - (2) Loops with similar or identical logic must each be tested individually.
 - (3) Test the boundaries of each numeric operator input by entering values outside of the allowable range.
 - d) Demonstrate the proper operation of all digital communication links and networks.
 - (1) Verify each digital communication I/O point.
 - e) Failure testing: Demonstrate how the system responds to and recovers from abnormal conditions including, but not limited to: equipment failure, operator error, communications subsystem error, communications failures, simulated/forced software lockups, power failure (both utility power and power to HMI and/or SCADA hardware), process equipment failure, and high system loading conditions.
 - 3) Test forms:
 - a) Submit completed test forms for each loop including but not limited to the fully revised and approved control strategy.
 - b) Identify the cause and effect as each I/O point is toggled through the simulator.
 - (1) Identify and track proper and/or improper operation of the loop.
 - c) Note any deficiencies or operational changes on the forms for correction and documentation:
 - (1) Include signature and date lines.
 - 4) Engineer approval of the FAT submittal is required prior to shipment of system components.
- 2. Owner training:
 - a. Demonstration requirements are specified in this Section.

Table 1			
Course Title	Minimum Course Length (hours per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
System Overview	4	10	1
Operator Training - Basic	4	10	1
Operator Training - Advanced	4	5	1
PLC Hardware	4	5	1
Network Equipment	4	5	1
Follow-Up Training	4	5	1
Instrument Training	4	5	1

3. Training course requirements:
 - a. System overview training:
 - 1) Furnish training courses that give the Owner's supervisory level personnel and overview of all elements of the PCIS system that focus on the overall functional aspect of elements of the control system and provide an understanding of the interaction of the various components.
 - 2) Furnish a training course that gives the Owner's supervisory level personnel and overview of the new Contractor-provided elements of the PCIS system. Focus on the overall functional aspects of each new elements of the control system, particularly the mechanical system vendor-provided control packages.
 - b. Operator training:
 - 1) Furnish training courses that instruct system operators in the efficient operation of all aspects of the PCIS that include not only the general operation of the control system but also the operation of specific system features.
 - 2) Furnish training courses that instruct system operators in the efficient operation of Contractor-provided aspects of the PCIS that include not only the general operation of each control system but also the operation of specific system features.
 - 3) Operator's training shall include the following for each vendor package and programmable device:
 - a) Control system overview: Architecture, equipment functions, software components, etc.
 - b) Display navigation, overview, and types of displays.
 - c) Process and equipment monitoring and control: Basic principles and operation.
 - d) Logging ON and OFF the system and description of the security and access system.
 - e) Alarm subsystem.

- f) Trending: Provide a thorough session on how to use all trending functions.
 - g) Reports: How to access, print, and review content.
 - h) Control strategies: Present an average 15-minute review of each control strategy, including a hands-on demonstration of screens and operator functions for each.
 - i) Instruction on the use of all operational functionality alarm logging, trending, displays, database, reports, and control software developed for the Project and incorporated in the installed PCIS system.
- c. PLC hardware training:
 - 1) Furnish training on PLC hardware and on related components, including battery backup equipment, UPSs, LOI hardware, control circuits, and analog circuits.
 - 2) Furnish training on PLC hardware principles, product features, proper installation, operation, troubleshooting, and maintenance.
 - 3) PLC training may be provided by manufacturer's certified trainers.
- d. Network equipment training:
 - 1) Furnish basic training on all network hardware, switch and router configuration and software, and network monitoring software.
 - 2) Include a detailed description and explanation of the installed network architecture, media, and functions.
 - 3) Furnish an overview of the function and operation of each piece of network equipment.
 - 4) Furnish training on network maintenance troubleshooting and repair.
 - 5) Furnish training on how to install spare or off-line backup equipment.
 - 6) Basic network overview:
 - a) Discuss a basic network overview for each site.
 - b) Discuss the architecture (loop, star, etc.), media redundancy, and items that are not readily apparent to staff.
 - c) Discuss how to monitor the network health through the HMI network screen.
 - d) Discuss both enterprise level networks, the PCS communications network, and the field network.
 - 7) Ethernet switches:
 - a) Discuss the various types of switches (Layer 2, Layer 3, etc.).
 - b) Discuss switch health monitoring through the HMI.
 - c) Discuss the VLAN configuration (what ports should be used for what network, etc.).
 - d) Discuss testing procedures.
 - 8) Field networks:
 - a) General:
 - (1) Discuss general principles behind likely device failures and actions to take to resolve such failures for each type of field network.
 - b) DLR networks:
 - (1) Discuss how to add non-DLR equipped devices to a DLR network.
 - (2) Discuss how to monitor and test DLR network health through an ETAP module or DLR capable switch.

- e. Follow-up training:
 - 1) Provide a series of on-site follow-up training classes beginning after process start-up of the SCADA/PCIS system. The intent for these classes is to provide the Owner's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.
 - 2) Mutually schedule and develop the content of these classes with the Owner no later than 1 month before the beginning of the first session:
 - a) Schedule at the Owner's discretion on non-consecutive days spaced out over the process start-up and warranty period.
- f. Instrumentation training:
 - 1) Furnish training covering all instruments and control panels.
 - 2) Furnish the specified quantity of training, allocated to cover new instruments and hardwired controls as specified in this Section and specifically determined in the accepted training plan.
 - 3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the instruments furnished within this Project.
 - 4) Furnish training on the operation of new hardwired controls.
- 4. Recording training sessions:
 - a. Record all training.
 - b. Furnish digital video disk (DVD) format.
 - c. These disks become the property of the Owner and cover, in detail, the training for the specific hardware and software of all the systems provided for the Project.
 - d. Provide all the necessary cameras and recording equipment.
- 5. Installation testing:
 - a. Calibration:
 - 1) Performed by Contractor and ICSC.
 - 2) Calibrate and adjust all instruments, devices, valves, and systems, in conformance with the component manufacturer's instructions and as specified in these Contract Documents.
 - 3) Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
 - a) Calibration for discrete devices:
 - (1) Calibrate and adjust devices for reliable operation and to avoid nuisance tripping.
 - b) Calibration for ultrasonic and radar level devices:
 - (1) Provide Echo Transmission and signal quality on level transmitters including guided and unguided units.
 - (a) Submit printout of the actual transmission and parameters.
 - (2) Adjust mounting, as required, to obtain accurate readings.
 - (3) Post mounting: Provide any additional calibration required by manufacturer.
 - c) Calibrating analog transmitters:
 - (1) Components having adjustable features are to be set accurately for the specific conditions and applications of this installation.

- (2) Test and verify that components and/or systems are within the specified limits of accuracy.
 - (3) Calibration points:
 - (a) Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to NIST.
 - (4) Field verify calibration of instruments including units that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
- d) Analyzer calibration:
 - (1) Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the manufacturers' technical representatives.
 - (2) Submit completed instrument calibration sheets for every field instrument and analyzer.
 - (3) Calibration tags:
 - (a) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
 - (b) Sign the tag when calibration is complete.
 - e) Calibration for industrial networking test equipment:
 - f) Submit calibration documentation.
- b. Loop check:
 - 1) Performed by the Contractor.
 - 2) Cabling installed, terminated, and labeled.
 - 3) Perform continuity check of wiring to each field device through intermediate devices to field terminals in the cabinet.
 - 4) Complete loop check form for each device.
 - 5) Submit loop check test results before proceeding to the next step.
- c. Loop validation tests:
 - 1) Performed by the Contractor, ICSC, and manufacturer's representative, working together, and witnessed by the Owner or Owner's representative.
 - 2) Perform tests on the signal from each field device through intermediate devices to the I/O module on the PLC.
 - a) The PLC may or may not be connected to the network.
 - 3) Engineer approval of the loop validation test submittal is required before proceeding to CEET.
- d. Copper Ethernet cable acceptance testing:
 - 1) All testing procedures and field-test instruments shall comply with applicable requirements of:
 - a) TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
 - b) TIA-568.0-E – Generic Telecommunications Cabling for Customer Premises.
 - c) TIA-568.1-E – Commercial Building Telecommunications Infrastructure Standard.
 - d) TIA-568.2-D – Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - e) Copper Ethernet cable installation testing

- 2) Testing shall be performed by trained technicians who have successfully completed an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - a) Manufacturer of the connectors or cable.
 - b) Manufacturer of the test equipment used for the field certification.
 - c) Training organizations (e.g. BICSI).
- 3) Submit the following information before testing begins:
 - a) Manufacturer's catalog sheets, specifications, and the most recent calibration report for the test equipment.
 - b) Certificate of testing technician's training.
 - c) A schedule of all balanced twisted-pair copper links to be tested, including:
 - (1) Cable identification as it appears on the cable records.
 - (2) Cable identification as it appears on the individual test reports.
 - (3) Cable identification as specified in Section 26_05_05 -
 - d) Sample test reports.
 - e) All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described below.
 - (1) Any Permanent Link that fails these requirements shall be diagnosed and corrected.
 - (2) Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements.
 - (3) The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation in accordance with the testing requirements.
 - f) Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Engineer.
- 4) Cable field-test instruments:
 - a) The field-test instrument shall be within the calibration period recommended by the manufacturer, typically 12 months.
 - b) Certification tester requirements:
 - (1) Level III in accordance with TIA-1152.
 - (2) Independent verification of accuracy.
 - (3) Must be capable of storing more than 10,000 results for all required measurements.
 - (4) Manufacturer: The following or equal:
 - (a) Fluke CableAnalyzer Industrial Ethernet Kit, DSX2-5-IE-K1.
 - c) Permanent Link adapters:
 - (1) Use manufacturer's adapter for connecting to tested equipment.
 - (a) Patch cables shall not be used for testing.

- (2) RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with TIA-568.2-D Annex C.
- d) Measurement capabilities:
 - (1) Wire Map.
 - (2) Length.
 - (3) Propagation Delay.
 - (4) Delay Skew.
 - (5) DC Loop Resistance.
 - (6) DC Resistance Unbalance.
 - (7) Insertion Loss.
 - (8) NEXT (Near-End Crosstalk).
 - (9) PS NEXT (Power Sum Near-End Crosstalk).
 - (10) ACR-N (Attenuation to Crosstalk Ratio Near-End).
 - (11) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End).
 - (12) ACR-F (Attenuation to Crosstalk Ratio Far-End).
 - (13) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End).
 - (14) Return Loss.
 - (15) TCL (Transverse Conversion Loss).
 - (16) ELTCTL (Equal Level Transverse Conversion Transfer Loss).
 - (17) Time Domain Reflectometer.
 - (18) Time Domain Xtalk Analyzer.
- 5) Testing requirements:
 - a) Field-test instruments shall have the latest software and firmware installed.
 - b) Permanent Link test results including the individual frequency measurements from the tester shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
 - c) Testing shall be performed on each cabling segment from connector to connector.
 - (1) Sampling is not acceptable.
 - d) The installer shall build a reference link.
 - (1) All components shall be anchored so it is not possible to disturb them.
 - (2) The technician is to conduct a Permanent Link test each day, for each type of category cable used, to ensure no degradation of the tester or its Permanent Link adapters.
 - e) Unless noted otherwise tests shall use the following frequency resolution:
 - (1) 1 – 31.25 MHz: 150 kHz.
 - (2) 31.25 – 100 MHz: 250 kHz.
 - (3) 100 – 250 MHz: 500 kHz.
 - f) Wire Map measurement:
 - (1) Wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For

- each of the 8 conductors in the cabling, the wire map indicates:
- (a) Continuity to the remote end.
 - (b) Shorts between any two or more conductors.
 - (c) Reversed pairs.
 - (d) Split pairs.
 - (e) Transposed pairs.
 - (f) Distance to open on shield.
 - (g) Any other miss-wiring.
 - (h) The correct connectivity of telecommunications outlets/connectors is defined in TIA-568.2-D.
 - 2 color schemes are permitted.
 - User shall define which scheme is to be used.
 - Field tester shall document which color scheme was used.
- g) Length measurement:
- (1) Record the length of each cable. Use the physical length of the link calculated using the pair with the shortest electrical delay for reporting and to determine pass/fail.
 - (2) Pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in TIA-568.D-2 plus the nominal velocity of propagation (NVP) uncertainty of 10 percent. For a Permanent Link, the length measurement can be 325 feet before a fail is reported.
- h) Propagation Delay measurement:
- (1) Is the time it takes for a signal to reach the end of the link.
 - (2) The measurement shall be made at 10 MHz in accordance with TIA-1152.
 - (3) The propagation delay of each balanced twisted pair shall be recorded.
 - (4) Is not to exceed 498 ns in accordance with TIA-568.2-D Section 6.4.21.
- i) Delay Skew measurement:
- (1) Is the difference in propagation delay at 10 MHz between the shortest delay and the delays of the other wire pairs.
 - (2) The delay skew of each balanced twisted pair shall be recorded.
 - (3) Is not to exceed 44 ns in accordance with TIA-568.2-D Section 6.4.22.
- j) DC Resistance:
- (1) Often reported as Resistance, is the loop resistance of both conductors in the pair.
 - (2) Is not specified in TIA-1152 but shall be recorded for all 4 pairs.
- k) DC Resistance Unbalance:
- (1) Often reported as Resistance Unbalance, is the difference in resistance of the 2 wires within the pair.
 - (2) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 4 pairs.

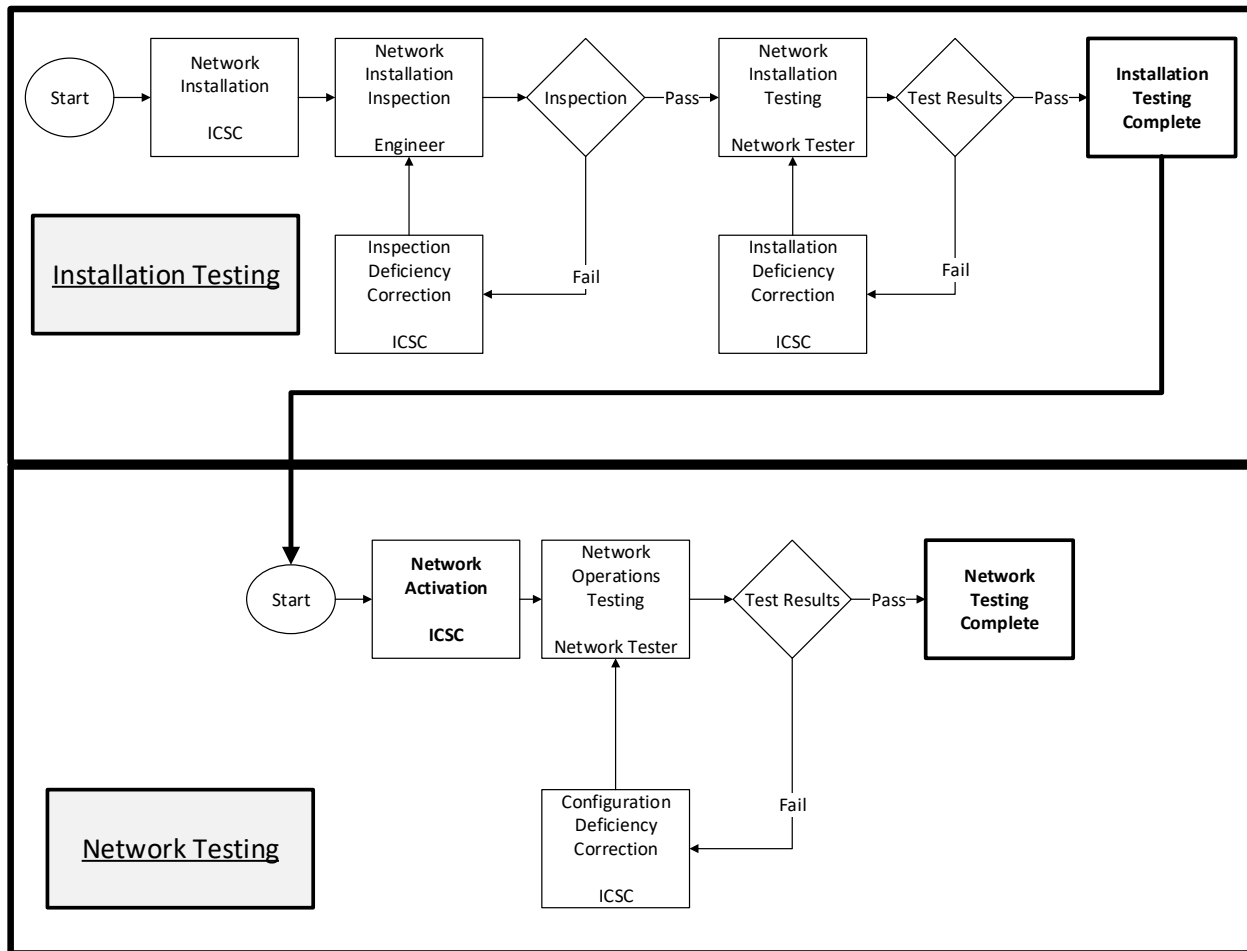
- l) Insertion Loss:
 - (1) Is the loss of signal strength over the cabling (in dB).
 - (2) Worst case shall be reported for all 4 pairs in one direction only.
 - (3) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk.
 - (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.10.
- m) NEXT (Near-End Crosstalk):
 - (1) Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
 - (2) Shall be measured in both directions (12 pair to pair possible combinations).
 - (3) Both worst case and worst margins shall be reported.
 - (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.11.
 - (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 - (6) The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.
- n) PS NEXT (Power Sum Near-End Crosstalk):
 - (1) Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
 - (2) Shall be measured in both directions (8 pair possible combinations).
 - (3) Both worst case and worst margins shall be reported.
 - (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.12.
 - (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 - (6) Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.
- o) ACR-N (Attenuation Crosstalk Ratio Near-End):
 - (1) Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
 - (2) Shall be calculated in both directions.
 - (3) Is not specified in TIA-1152 but shall be recorded for all 12 possible combinations.
- p) PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End):
 - (1) Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
 - (2) Shall be calculated in both directions.
 - (3) Is not specified in TIA-1152 but shall be recorded for all 8 possible combinations.
- q) ACR-F (Attenuation Crosstalk Ratio Far-End):
 - (1) Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.

- (2) Shall be measured in both directions (24 pair to pair possible combinations).
- (3) Both worst case and worst margins shall be reported.
- (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.14.
- (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- r) PS ACR-F (Power Sum Attenuation Crosstalk Ratio Far-End):
 - (1) Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.
 - (2) Shall be measured in both directions (8 pair possible combinations).
 - (3) Both worst case and worst margins shall be reported.
 - (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.16.
 - (5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- s) Return Loss:
 - (1) Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
 - (2) Shall be measured in both directions (8 pair possible combinations).
 - (3) Both worst case and worst margins shall be reported.
 - (4) Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
 - (5) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.9.
 - (6) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 - (7) Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.
- t) TCL (Transverse Conversion Loss):
 - (1) Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
 - (2) Shall be measured in both directions.
 - (3) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.
- u) ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - (1) Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
 - (2) Shall be measured in both directions.
 - (3) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.

- 6) Test results documentation:
- a) The detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and shall contain the following information:
 - (1) The overall Pass/Fail evaluation of the link-under-test.
 - (2) The date and time the test results were saved in the memory of the tester.
 - (3) The identification of the customer site as specified by the end-user.
 - (4) The name of the test limit selected to execute the stored test results.
 - (5) The name of the personnel performing the test.
 - (6) The version of the test software and the version of the test limit database held within the test instrument.
 - (7) The manufacturer, model and serial number of the field-test instrument.
 - (8) The adapters used.
 - (9) The factory calibration date.
 - (10) Wire Map.
 - (11) Propagation Delay values, for all 4 pairs.
 - (12) Delay Skew values, for all 4 pairs
 - (13) DC Resistance values, for all 4 pairs
 - (14) DC Resistance Unbalance, values for all 4 pairs
 - (15) Insertion Loss, worst case values for all 4 pairs
 - (16) NEXT, worst case margin and worst case values, both directions
 - (17) PS NEXT, worst case margin and worst case values, both directions
 - (18) ACR-F, worst case margin and worst case values, both directions.
 - (19) PS ACR-F, worst case margin and worst case values, both directions.
 - (20) Return Loss, worst case margin and worst case values, both directions.
 - (21) TCL, worst case values both directions.
 - (22) ELTCTL, worst case values, both directions.
 - (23) Time Domain Crosstalk data if the link is marginal or fails.
 - (24) Time Domain Reflectometer data if the link is marginal or fails.
 - b) Maintain a set of "red-line" throughout during construction.
 - (1) Drawings shall be available for review at any time as requested by Owner or Engineer.
 - (2) Provide record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point.
 - (3) The as built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination

- points, equipment room layouts and frame installation details.
- (4) The as builds shall include all field changes made up to construction completion:
 - (a) Field directed changes to pull schedule.
 - (b) Horizontal cable routing changes.
- 7) Associated detail drawings. Engineer approval of the copper Ethernet cable acceptance-testing submittal is required before proceeding to CEET.
- e. Industrial network testing:
 - 1) General test requirements:
 - a) Contractor will hire a 'Network Tester' who is a Certified Profibus Installer for testing for the proper installation and operation of the Profibus network.
 - b) Provide necessary components and labor required to address changes required to bring the network into compliance.
 - c) Personnel shall be available at the time of network inspection and testing to address network deficiencies.
 - d) Before commencing any network inspection or testing activities:
 - (1) Verify that network segments and nodes are in their final installed condition.
 - (a) Network node devices installed.
 - (b) Field devices physically disconnected from the network.
 - (2) Process and process equipment is not dependent on operation of the network.
 - (3) Inspect network components and deficiencies addressed.
 - (4) Manufacturer's data and specifications for installed network components, available on-site for use by the network testing firm.
 - (5) A complete set of Contract Documents included addenda and change orders are available on-site for use by the network testing firm.
 - e) Network operation may be interrupted for inspection and testing.
 - f) Figure 1, Network Test Sequence and Responsibilities, defines the general test sequence.

Figure 1 - Network Test Sequence and Responsibilities



2) Test equipment:

a) Use the following test equipment:

- (1) Network line analyzer: ProfiTrace v1.6 or equivalent.
- (2) Oscilloscope: Fluke Scopemeter Series 190 or equivalent.
- (3) Digital VOM: Fluke 87 Multimeter or equivalent.
- (4) Network bus monitor, ProfiTrace v1.6 or equivalent.

3) Network installation testing:

- a) Performed by Contractor/ICSC, Network Tester, and Owner's representative working together.
- b) This activity focuses on the physical media and its installation.
- c) Conduct a physical inspection to establish the network configuration as indicated on the Drawings:
 - (1) Validate the node type and quantity.
 - (2) Identify improper installation and damaged components.
- d) Validate integrity of cables and connectors via a physical media test to confirm the signal propagation capabilities of the network media using visual and mechanical inspection:
 - (1) Compare network devices nameplate data with drawings and specifications.
 - (2) Confirm network components are PTO compliant.

- (3) Verify labeling of trunk cables.
- (4) Confirm permissible cable length.
- (5) Confirm correct cable type.
- (6) Verify the presence/absence of stub lines.
- (7) Verify network terminators are in place.
- (8) Verify power supply source and connections for active terminations.
- (9) Verify total network node count.
- (10) Verify power supply specifications including quantity, ratings, locations, and configuration. Verify power supply source of supply location, conductor size, and rating.
- (11) Inspect accessible network cabling for adherence to specified installation practices:
 - (a) Cable installed in conduit or protective raceway.
 - (b) Cable proximity to high voltage wiring.
 - (c) Exposure to extreme temperatures, shock, vibration, chemicals, or moisture.
 - (d) Bend radius.
- (12) Inspect cable and conductor terminations for adherence to specified installation practices.
- (13) Check all accessible components for evidence of physical damage.
- (14) Check grounding techniques including ground conductor sizes and termination points.
- (15) Eliminate signal reflections.
- e) Electrical tests:
 - (1) Measure total network resistance.
 - (2) Cable length and configuration evaluation:
 - (a) Confirm the network cable topology (length and configuration) does not exceed data rate limitations.
 - (b) Confirm total stub length (if required by design) does not exceed data rate limitations.
 - (c) Calculate spare trunk length for the specified data rate.
 - (3) Line analysis for the following conditions:
 - (a) Short circuit between signal lines A and B.
 - (b) Short circuit between signal lines A and B and the cable shield.
 - (c) Shield continuity.
 - (d) Cross-wired signals lines.
 - (e) Terminator installed in wrong position.
 - (f) Poor transmission or reception levels.
 - (g) Non-permissible stub line.
 - (4) Examine the data traffic between the controller and each agent device.
 - (5) Verify baud rate meets specified requirements.
 - (6) Confirm signal level meets specified requirements.
 - (7) Verify network cycle time meets specified requirements.
 - (8) Generate agent device list.
 - (9) Verify and record scanner diagnostic data including node status and error codes.

- (10) Monitor and capture network waveform.
- (11) Measure and record power supply voltage at active terminations.
- f) Submit corrective measures recommendations based on the results of the inspections and testing.
- g) Engineer approval of the network installation validation and testing submittal is required before proceeding to network operations validation and testing.
- 4) Network Operations Testing:
 - a) Performed by Contractor/ICSC, Network Tester, Owner's representative and Programmer working together.
 - b) General requirements:
 - (1) The network performance is monitored and measured using non-intrusive test equipment and procedures in accordance with the Referenced standards:
 - (a) Profibus networks.
 - (2) Modifications required as a result of network operations validation and shall be in conformance with the applicable standards from Profibus organization, North America, PTO.
 - c) Online evaluation:
 - (1) Confirm specified agent devices appear on the live list.
 - (2) Evaluate data traffic between controller and each agent to confirm proper agent configuration and performance.
 - (3) Inspect waveform capture for evidence of excessive noise.
 - (4) Evaluate and report any failed or questionable network tests.
 - (5) Evaluate and report network error codes and related symptoms.
 - d) Network Operations Validation and Testing Report:
 - (1) Prepare a report that documents the results of the qualification and testing activities include, but not limited to, the following:
 - (a) Document the installed condition of the network and provide baseline values for future network maintenance and testing activities.
 - (b) Executive summary for each network including the following:
 - Inspection and test results for each network.
 - Calculated network parameters.
 - Recommendations.
 - Description of test procedures and required test equipment.
 - Network agency specifications.
 - (c) Manufacturer's specifications and guidelines:
 - Include applicable manufacturer's specifications and guidelines.
 - Manufacturer's specifications and guidelines may supersede the specifications of the applicable governing body for the associated network but at

- a minimum must meet the governing body's requirements.
- e) Submit final report of the industrial network testing to the Engineer upon successful completion of the testing.
- 5) Engineer approval of the industrial network testing submittals is required before proceeding to CEET.
- f. Complete End-to-End Testing (CEET):
 - 1) Performed by Contractor, ICSC, and manufacturer's representative, and Programmer working together, with assistance from the OWNER or the inspection staff, as needed.
 - a) The participants need to be dedicated full-time to CEET.
 - b) ICSC will provide staff to verify input signals at, and create output signals from, an HMI or Engineering Workstation.
 - c) Contractor and ICSC will be responsible for creating field signals and verifying proper operation of final control elements.
 - 2) Prerequisites:
 - a) CEET cannot begin until the successful completion of the preceding tests:
 - (1) Calibration.
 - (2) Loop check.
 - (3) Loop validation tests.
 - (4) Copper Ethernet cable acceptance testing.
 - (5) Industrial network testing.
 - 3) Testing description:
 - a) This testing is to ensure all I/O signals operate to the intent of the design from the field device to the HMI and all other auxiliary controls and indicators in the PCS.
 - b) Connect PLC to the network to test signals from the field device through the PLC program, the network, and to the operator's HMI graphic screens. The outputs will be energized for a duration long enough to verify proper operation of the final control element.
 - c) SCADA screens:
 - (1) Test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
 - (2) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
 - (3) Retest any loop following any necessary corrections.
 - 4) Check control loops under simulated operating conditions by causing a range of input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the HMI/SCADA system.
 - a) Use actual process inputs wherever available.
 - b) Issue commands from the HMI/SCADA system and verify proper responses of field devices.
 - (1) Test SCADA system inputs from field device to SCADA system operator workstations.

- (a) Track responses through trend charts in the HMI/SCADA system.
 - (2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.
- 5) Discrete device testing:
 - a) Exercise each field device providing a discrete input to the HMI/SCADA system in the field and observe the proper operation shall be observed at the operator workstation:
 - (1) Test limit switches, set limits mechanically, and observe proper operation at the operator workstation.
 - (2) Exercise starters, relay contacts, switch contacts, and observe proper operation.
 - (3) Calibrate and test instruments supplying discrete inputs and observe proper operation.
 - b) Test each device accepting a discrete output signal from the HMI/SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device:
 - (1) Stroke valves through outputs from the HMI/SCADA system, and confirm proper directional operation. Confirm travel limits and any feedback signals to the HMI/SCADA system.
 - (2) Exercise motors starters from the HMI/SCADA system and verify proper operation through direct field observation.
 - (3) Exercise solenoids and other field devices from the HMI/SCADA system and verify proper operation through direct field observation.
- 6) Analog device testing:
 - a) Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
 - b) Apply provisional settings on controllers and alarm setpoints.
- 7) Analog input:
 - a) Exercise each field device monitoring the analog signal, through the HMI/SCADA system.
 - (1) Apply simulated sensor inputs corresponding to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span for networks that incorporate analog elements and monitor the resulting outputs to verify compliance to accuracy tolerance requirements.
- 8) Analog output:
 - a) Exercise each field device requiring an analog command signal, through the HMI/SCADA system.
 - (1) Vary the output from the PLC HMI/SCADA system and measure the end device position, speed, etc. to confirm the proper operation of the device for the supplied analog signal.
 - (2) Manually set the output from the HMI/SCADA screen at 0 percent, 25 percent, 50 percent, 75 percent, and

- 100 percent and measure the response at the final device and at any intermediate devices.
- 9) Submit completed test forms.
- a) Discrete instrument input devices:
 - (1) Switch setting, contact action, and dead band.
 - (2) Valve position switches:
 - (a) Response in the PLC as the valve is stroked from the PLC.
 - (b) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
 - (3) Operator interface switches (control stations and other pilot devices) and associated response.
 - (4) Starter and drive auxiliary device contact response.
 - (5) Response of all other discrete inputs to the PLC.
 - (6) Test equipment used and associated serial numbers.
 - b) Discrete output devices:
 - (1) Observed response of field device to the discrete output from the PLC.
 - (2) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
 - (3) Test equipment used and associated serial numbers.
 - c) Analog input devices:
 - (1) Calibration range.
 - (2) Calibration data: Input, output, and error at each test value.
 - (3) Analog input associated PLC register address.
 - (4) Value in PLC register at each test point.
 - (5) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
 - (6) Test equipment used and associated serial numbers.
 - d) Analog output devices:
 - (1) Calibration range.
 - (2) Test value at each test point.
 - (3) Analog output associated PLC register address.
 - (4) Control variable value at field device at each test point.
 - (5) Physical device response at each test point:
 - (c) Response to be actual valve position, or motor speed, etc.
 - (6) Test equipment used and associated serial numbers.
- 10) Failure testing:
- a) Demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
 - (1) Equipment failure.
 - (2) Communications sub-system error.
 - (3) Power failure.
 - (4) Process equipment failure.
 - (5) High system loading conditions.
- 11) Engineer approval of the CEET submittals is required before proceeding to Functional Testing.

6. Functional testing:
 - a. General:
 - 1) Testing to demonstrate proper operation of systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
 - 2) Performed by Contractor, ICSC, and manufacturer's representative, and Programmer working together, with assistance from the OWNER or the inspection staff, as needed.
 - 3) Additional tests are specified in other Instrumentation and Control Sections.
 - 4) Follow approved detailed test procedures and check lists for Functional Test activities.
 - b. Control logic operational validation:
 - 1) The purpose of control logic validation is to field test the operation of the complete control system, including all parts of the HMI/SCADA system, all control panels (including vendor control panels), all control circuits, all control stations, all monitored/controlled equipment, and final control elements.
 - 2) Demonstrate control functionality shown on the P&IDs, control schematics, and other drawings, and specified in the loop descriptions, control strategies, Electrical Specifications, and Mechanical Equipment Specifications.
 - 3) Test in detail on a function-by-function and sentence-by-sentence basis.
 - 4) Thoroughly test hardware and software functions:
 - 5) Including all hardwired and software control circuit interlocks and alarms.
 - 6) Test final control elements, controlled equipment, control panels, and ancillary equipment under startup, shut down, and steady-state operating conditions to verify all logic and control is achieved.
 - 7) Control logic validation tests to include, but not limited to: a repeat of all control logic tests from the FAT, modified and expanded to include all field instruments, control panels, circuits, and equipment.
 - c. Loop tuning:
 - 1) Optimally tune all electronic control stations and software control logic incorporating proportional, integral, or derivative control. Apply control signal disturbances at various process variable levels and adjusting the gain, reset, or rate settings as required to achieve proper response.
 - 2) Verify the transient stability of final control elements operating over the full range of operating conditions, by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates. As a minimum, achieve 1/4-wave amplitude decay ratio damping (subsidence ratio of 4) under the full range of operating conditions.
 - 3) If excessive oscillations or system instability occur, as determined by the Engineer, continue tuning and parameter adjustments, or develop

and implement any additional control algorithms needed to achieve satisfactory control loop operation.

- 4) Functional validation sheets:
 - a) Document each Functional test on an approved test form.
 - b) Document loop tuning with a report for each loop, including two-pen chart recordings showing the responses to step disturbance at a minimum of 3 setpoints or process rates approved by the Engineer. Show tuning parameters on the charts, along with time, date, and sign-off by Contractor and Engineer.
 - c) Include on the form, functions which can be demonstrated on a loop-by-loop basis:
 - (1) Loop number and P&ID number.
 - (2) Control strategy, or reference to specification tested.
 - (3) Test procedures: Where applicable, use the FAT function-by-function, sentence-by-sentence loop test checklist forms modified to meet the requirements of the Functional test. Otherwise, create new forms.
 - d) For functions that cannot be demonstrated on a loop-by-loop basis (such as overall plant power failure), include on the test form a listing of the specific steps and tests to be conducted. Include with each test description the following information:
 - (1) Specification page and paragraph of function demonstrated.
 - (2) Description of function and/or text from specification.
 - (3) Test procedures: use the FAT loop test checklist forms modified to meet the specific testing conditions of the Functional test.
- 5) Functional certification:
 - a) Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.
 - (1) Including all test forms with test data entered, submitted to the Engineer with a clear and unequivocal statement that all Functional test requirements have been satisfied.

7. Clean Water Facility Testing:

- a. Programmer shall be onsite to support Clean Water Test activities and provide functional changes as required.
 - 1) ICSC shall be available as needed.
- b. ICSC shall be onsite to support Clean Water Test activities and provide functional changes as required.

C. Process Start-up Phase:

1. Process Start-up:

- a. Programmer shall be onsite to support Process Start-up activities and provide functional changes as required.
 - 1) ICSC shall be available as needed.
- b. ICSC shall be onsite to support Process Start-up activities and provide functional changes as required.

2. Process Operation Period:
 - a. Programmer shall be available to support Process Operational Period and provide functional changes as required.
 - 1) ICSC shall be available as needed.
 - b. ICSC shall be available to support Process Operational Period and provide functional changes as required.
3. PCIS Optimization and Fine-Tuning:
 - a. General:
 - 1) After the Process Operational Period, test PCIS system for additional 60 days as specified in this Section to identify issues and make corrections, as needed.
 - 2) This is part of the Work that must be completed as a condition of substantial completion and final completion for the entire Project.
 - 3) The complete PLC control and HMI/SCADA system must run continuously for the duration of the PCIS Optimization and Fine-Tuning.
 - 4) Test and use the entire process control system under standard operating conditions.
 - 5) Exercise all system functions.
 - 6) Log failure, any system interruption and accompanying component, subsystem, or program failure including time of occurrence, duration of each failure, failure classification, and cause:
 - a) Provide a competently trained technician or programmer on call for the Project Site during all normal working days and hours from the start of the PCIS Optimization and Fine-Tuning until final acceptance of the system.
 - (1) Response time to the Project Site: 24 hours or less, for a major failure.
 - b. SCADA system testing:
 - 1) Exercise each system function, e.g., status report, alarms, logs, and displays several times at a minimum, and in a manner that approximates "normal" system operation.
 - 2) Failure of the HMI/SCADA system during testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications.
 - a) Corrective action is required before restarting the PCIS Optimization and Fine-Tuning.
 - 3) Only those components, sub-systems, and systems covered in this Section and supplied under this Contract shall be considered for this acceptance test. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.
 - 4) Failures:
 - a) Classify failures as either major or minor:
 - (1) Minor failure:
 - (a) A small and non-critical component failure or software problem that can be corrected by the Owner's operators.

- (b) Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
 - (c) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
 - (d) Failure of one printer or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e., alternate printers and operator station, and repairs can be made and equipment returned to service within 3 working days.
- (2) Major failure:
 - (a) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
 - (b) Cause termination of the PCIS Optimization and Fine-Tuning.
 - (c) Start a new acceptance test when the causes of a major failure have been corrected.
 - (d) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or underdose condition occurs.
- 5) Technician report:
 - a) Each time a technician is required to respond to a system malfunction, they must complete a report, which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
 - b) If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.
 - c) If a technician has performed work but no report is written, then a major failure is considered to have occurred.
 - d) Each report shall be submitted within 24 hours to the Engineer and the Owner, or its representative.

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 RE-INSTALLATION (NOT USED)

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES

- A. Example test forms:
 - 1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of Project-specific test forms for this Project.
 - 2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

END OF SECTION

ATTACHMENT A - FACTORY ACCEPTANCE TEST - CONTROL PANELS

	FACTORY ACCEPTANCE TEST - CONTROL PANELS	
1. GENERAL INSPECTION A. Structural Inspection ☐ Verify Lifting Lugs Installed ☐ Verify enclosure has lock and lock is functional B. Exterior Inspection ☐ Cabinet exterior is clean, scratch, and dent free ☐ Inspect externally for corrosion and damage ☐ Verify enclosure door opens and closes easily ☐ Verify enclosure has a 3-point latch ☐ Verify enclosure has a flange mounted disconnect (where voltages greater than 120 VAC enter the cabinet) ☐ Verify enclosure has the appropriate NEMA rating (1, 1G, 12, 3R, 4, 4X, etc.) ☐ Verify enclosure is the appropriate size (not grossly larger than design, and will still fit in the plant) Nameplates ☐ Cabinet has identification nameplate ☐ All door labels are straight, spelled correctly, and match the tagging defined in the Contract ☐ Cabinet has a nameplate that includes the following: ☐ Power source(s) ☐ Integrator's Logo ☐ Circuit ID(s) ☐ Short Circuit KAIC ratings ☐ If labels are screwed to door, silicone was utilized to cover screw holes (Labels screwed to the door of a NEMA 4/4X panel technically violates the NEMA rating.) Door Devices ☐ All devices penetrating the outside of panel have gaskets, silicone or both ☐ All door devices are installed (HMIs, Pilot Devices, etc.) ☐ Door mounted equipment is mounted straight and square ☐ All exterior or door mounted equipment present and accounted for, installed and securely fastened ☐ NEMA classification has not been violated due to penetrations ☐ Door mounted equipment has the same NEMA rating as the panel ☐ All door mounted equipment installed at the correct height ☐ All door mounted equipment installed in the correct positions and order (layout of door mounted equipment is grouped properly and in a logical manner) ☐ Doors with multiple penetrations have adequate bracing (if needed) ☐ Visually check condition of indicators , controllers and annunciators ☐ Check that pilot lights illuminate correctly ☐ Check the Push-To-Test function ☐ Ensure correct pilot light color Peripheral Devices ☐ Horn / Beacon is installed (where required) ☐ Silence and Reset pushbutton		
PROJECT NAME: _____		TEST DATE: _____
FACILITY NAME: _____		TESTED BY: _____
PROCESS AREA: _____		COMPANY: _____
NETWORK ID: _____		PAGE: _____
WITNESSED BY: _____		SIGNATURE: _____

	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
1. GENERAL INSPECTION (continued) C. Interior Inspection ☐ Cabinet is cleaned of marks and dirt. ☐ Inspect internally for corrosion and damage. ☐ Back panel is clean of marks and dirt. ☐ Interior of panel vacuumed and shall be free of all debris. ☐ Check that the panel roof is clean and clear of foreign materials. ☐ Bottom of panel has been cut out (where bottom entry is required), with angle iron welded around the bottom perimeter. Re-painting has been performed. ☐ If internal light door limit switch is provided, ensure the light automatically turns "on" when the doors are open. ☐ Check that a document pocket has been provided. ☐ Intrusion alarms (where required). Interior Labeling ☐ All panel mounted equipment has identification labeling, by using either a Brothers or Phenolic type tags. ☐ Verify that door mounted components are mounted square and symmetrical. ☐ Verify that nameplates are straight, legible, and spelled correctly. ☐ All terminal blocks are identified/labeled with permanent labels including tight end blocks and caps. ☐ All wiring shrink labeled and or phased correctly to the specifications. ☐ All wire labels shrunk completely rotated and aligned alike for easy identification. ☐ All fuses and circuit breakers are labeled with ID and current rating. ☐ System Integrator's label or labels installed on door. ☐ Panel manufacturer model/serial number tag is present. ☐ All required safety/warning tags installed and straight. ☐ Correct UL (typically UL 508) or cUL tag installed and registered and all other associated tags installed and straight (the UL tag might not be installed in the panel at the factory test. If the panel is modified due to changes during the factory test or a punch list generated from the factory test, the UL labeling would need to be re-applied. Some UL shops do not apply the UL label until the panel is released to be shipped.). Wireways ☐ Plastic wire way covers installed properly. ☐ Plastic wireways have no sharp edges. ☐ No wire Ties inside the wireways. ☐ No sharp edges on wire ties. ☐ Separation: White duct is used for DC voltages, Gray duct is used for AC voltages. ☐ Ensure wiring duct is not over-full, includes provision for 20% more wiring and the cover may easily be installed. Panduit recommends 50% duct fill, but 40% is a better practice.												
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	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
1. GENERAL INSPECTION (continued) C. Interior Inspection (continued) Wiring ☐ Visually check terminals and condition of internal wirings ☐ Verify that the control panel has been assembled and wired as designed ☐ Verify that all components are operational and perform the functions intended ☐ Verify that all components are sized appropriately for the application ☐ Verify that equipment control circuits function as intended ☐ Back of door wiring is labeled and neatly formed ☐ Back panel to door wiring has sufficient bending radius with spiral wrap ☐ Wire connection has been verified wired to correct points within the panel ☐ Individual wires have been given a pull test to verify a good terminal connection ☐ Wire and cable minimum bending radius have not been violated ☐ All equipment installed straight and square to back panel ☐ Wire colors are correct: ☐ Black and White > AC hot and neutral, respectively ☐ Red > AC control signals ☐ Blue > DC power and control (Blue w/White stripe for DC ground) ☐ Yellow > Foreign voltages (those still present when panel power is disconnected) ☐ Green > AC equipment ground ☐ Black > TSP (+) ☐ White > TSP(-) ☐ Analog wiring shields are continuous (connected by a dedicated terminal block for such shields) ☐ Analog shield wires are grounded within the panel, where not otherwise grounded at the transmitter itself ☐ Discrete inputs are separately fused or protected by a circuit breaker on a "per loop" basis ☐ Intrinsic Safety Wiring ☐ Ensure wiring associated with intrinsic safety circuits or intrinsic safety barriers is kept away from all other wiring by UL minimum distances or by a physical (grounded metal) barrier preventing non-intrinsically safe wiring from coming in contact with intrinsically safe circuits or wiring ☐ Verify all spare terminals are installed according to the percentage listed in the specifications Grounding ☐ Equipped with "Blackburn" or other grounding type lug ☐ Lug is securely fastened to the panel structure ☐ Verify Grounding bar is installed ☐ Verify Isolated ground bar is installed												
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	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
2. POWER TEST A. AC Power ☐ AC Power is routed correctly within the panel, and is isolated from DC and network wiring. ☐ All fuses are installed and sized properly. ☐ All breakers are installed and sized properly. ☐ 24 VDC Power Supplies are functional. ☐ 24 VDC Power fail contacts are functional. ☐ 24 VDC power supplies are redundant, and have diode modules enabling the hot swap-over between supplies. ☐ 24 VDC supplies are equipped with dry contact failure alarms, wired as PLC inputs to signal failure of any DC power supply. Such alarm inputs to the PLC have been tested as being functional. ☐ Dedicated receptacle is wired to receive a dedicated AC supply. ☐ Verify continuity for all DC commons, ground and AC neutrals. ☐ Verify that the CP temporary input power is connected correctly and is the correct voltage. ☐ Close the CP main circuit breaker(s). ☐ Verify that voltages at subsequent circuit breakers are correct. ☐ Close circuit breakers. ☐ Verify that power feeding interruptible and uninterruptible power supplies is correct. ☐ Turn on power supplies if they are not already on. ☐ Verify that voltages at distribution terminals are correct. ☐ Energize any remaining hardware such as the PLC. B. Uninterruptible Power Supply (UPS) ☐ Mounted appropriately within the cabinet, on a dedicated shelf, or rear of a swing-out sub panel. ☐ Is equipped with maintenance bypass switch (or at least plug/receptacle means for bypassing the unit). ☐ Test all UPS alarms (on inverter, failure, battery failure etc.) ☐ Turn off the AC power supply and verify that the UPS will be switched on to supply the designated vital loads in the control panel. 3. CONTROLS & AUXILIARY DEVICES TEST ☐ Verify all interposing and auxiliary relays are functioning. ☐ Verify panel lights are functioning. Ventilation and Heating ☐ If ventilation fans are fitted, check the fans operate correctly any associated air filters are clean and not blocked. ☐ Verify components are installed in the correct orientation for proper air flow. 4. HARDWIRED INTERLOCK AND SAFETY TEST ☐ Verify that hardwired interlocks through the control panel as shown on schematic drawings are functioning. For example, outlet high pressure switch interlock to a pump. ☐ Verify that all hardwired safety devices through the control panel is functioning. For example, the pull cord emergency stops of conveyors.												
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	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
5. PLC TEST A. Components ☐ PLC interior High Temperature alarm is installed, wired to the PLC, and is shown to be functional. ☐ Relays have transient suppression across their coils. This is particularly important for DC coil relays, where diodes in reverse polarity are often used. ☐ TVSS is installed across the main incoming 120 VAC. PLC and PLC Rack ☐ Verify all cards are securely seated. ☐ Ensure clearance around PLC rack has been met, such that convective heat transfer is not impeded by devices erroneously mounted in the "no encroachment" area. Confirm with manufacturer clearance recommendations. B. PLC I/O Test ☐ Furnish I/O test forms and test all the listed input and output points as follows: ☐ Discrete Inputs: Simulate a field contact closure by "shorting" across the appropriate terminal blocks. Observe the transition between a logical "0" and "1" in the PLC software. ☐ Discrete Outputs: Force the output bit to toggle between logical "0" and logical "1" using the PLC software. Measure contact resistance at the wired terminal blocks using a digital meter selected for the "ohms" setting. ☐ Analog Inputs: Connect a signal generator to the appropriate terminal blocks. Tailor the connection depending on whether a 2-wire or 4-wire simulation is required. Modulate the 4-20mA signal. Observe the associated PLC internal memory register to transition between 0-65535 or if scaled in engineering units, between 0 and the maximum scaled engineering unit. The latter method is preferred. ☐ Analog Outputs: Force the output register to a value between 0-65535 or 0-100%, if the scaling block can be manipulated. Observe the measured 4-20mA value increment and decrement using a digital ammeter. C. Redundant Controllers (where required) Test ☐ Remove Communication cable from primary PLC to verify switching to backup PLC ☐ Remove Communication cable from backup PLC to verify switching back to primary PLC ☐ Remove Power cable from primary PLC to verify switching to backup PLC ☐ Remove Power cable from backup PLC to verify switching back to primary PLC D. PLC Control Logic Verification ☐ The PLC control strategy is verified by following the Control Logic Verification Form based on the specifications. Each control strategy will be verified by simulating the process and checking the state or value of PLC outputs. The results of equipment status and alarms and process instrument values and trends shall also be verified on the Plant SCADA graphic screens stored in a temporary SCADA computer. Since all PLC input and output wiring has been verified and some field devices are not available during Factory Acceptance Testing, certain inputs will be simulated either by means of additional hardware and/or software as described below. ☐ ☐ ☐ DI states are either simulated by hardwired switches or forced inputs using a programming terminal. ☐ For example, when starters and drives are not provided as part of the contract, jumpers may be installed from the output call relays to the running confirmation inputs to simulate the running state of the motors.												
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	FACTORY ACCEPTANCE TEST - CONTROL PANELS											
5. PLC TEST (continued) D. PLC Control Logic Verification (continued) Typical Fault Logic ☐ If the fault input is high and the disable (if applicable) for the fault is not high and the common disable (if applicable) is not high begin timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output. If the fault alarm is a shutdown alarm stop the associated motor and latch the alarm so that it remains present even if the condition clears. ☐ The fault condition must return to normal and the alarm must be reset for a latched alarm to clear. Typical Fail to Start Logic ☐ If the motor is called to run (call output high) and no running feedback is received (running input is low) and the fail to start and common alarm disables (if applicable) are not high start timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output, stop calling the motor and latch the alarm. 6. HMI OR OIT TEST HMI / OIT Functionality ☐ Communication with PLC ☐ Screen Layouts ☐ Screen Navigation ☐ Set Point Entry ☐ Animation ☐ Color Correctness (Green=Run, Red=Off, Amber=Alarm, or the agreed upon convention) ☐ Alarms ☐ Acknowledge and Reset ☐ Security / Access Levels / Passwords 7. NETWORK COMMUNICATION TEST A. Network Components ☐ Fiber optic cabling terminates in a patch panel ☐ Media converters are installed and functional ☐ Terminating resistors have been installed for trunk/tap topologies or where required ☐ Wire and cable bending limitations have not been violated B. Networking Functions ☐ Verify data transfer via the network to different PLCs as shown on the Network Block Diagrams ☐ Verify network traffic rate and error margin is acceptable												
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	FACTORY ACCEPTANCE TEST - CONTROL PANELS			
8. FAT DOCUMENTATION AND RECORD Panel Documentation ☐ As-built panel drawings showing actual panel construction and devices arrangement and c/w Bill of Material. ☐ Panel schematic and interconnection drawings. ☐ P&ID drawings and schematic drawings for the process area controlled by the panel that is to be tested. ☐ I/O list test forms of the process area to be tested. ☐ FAT procedure of the process area to be tested. ☐ Test record forms of the process area to be tested. Forms shall include area for signature of responsible test personnel. ☐ Hard copy of the PLC application program of the process area to be tested. ☐ Hard copy of the HMI/OIT graphic screens of the process area to be tested. 9. FAT TOOLS AND SOFTWARE ☐ Simulation software if required ☐ Digital volt meter Fluke 87 ☐ Process meter Fluke 787 ☐ Laptop computer with PLC application program ☐ Temporary SCADA computer with HMI software and applicable graphic screens ☐ Jumper wires				
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WITNESSED BY: _____ SIGNATURE: _____

ATTACHMENT B - INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION

	INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

A COPY OF LATEST ISSUE OF THE FOLLOWING DOCUMENTS ARE INCLUDED IN THIS INSTRUMENT INSTALLATION
CERTIFICATION FILE:

- ☐ INSTRUMENT SPECIFICATION SHEETS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT INSTALLATION DETAILS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT LOOP WIRING DIAGRAMS
- ☐ INSTRUMENT INSTALLATION CERTIFICATION CHECKLIST
- ☐ SIZING CALCULATIONS
- ☐ INSTRUMENT INSTALLATION SCHEDULE (APPLICABLE PART)
- ☐ NAMEPLATE SCHEDULE (APPLICABLE PART)
- ☐ VENDOR LITERATURE CALIBRATION INFORMATION

	☐	☐
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?	No	Yes

REMARKS: _____

CHECKED BY (COMPANY) _____	ACCEPTED BY (COMPANY) _____

SIGNATURE _____	SIGNATURE _____

DATE _____	DATE _____

ATTACHMENT C – SWITCHES INSTALLATION AND CALIBRATION CHECKLIST

	SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, WHEN COMPLETED:

- ☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____
- ☐ VERIFIED PER P&ID NO. _____
- ☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____
- ☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____
- ☐ INSTALLATION CORRECT PER DETAIL NO. _____
- ☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED
- ☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL
- ☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

No Yes

<u>FIELD CALIBRATION CHECK</u>						
CONTACT NO.	FUNCTION	FOR SIGNAL	CONTACT IS TO	AT SPECIFIED VALUE FOR	ACTUAL TRIP POINT WAS	
1	☐ ALARM	☐ INCR	☐ OPEN	SET PT = _____	SET PT = _____	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET = _____	RESET = _____	
2	☐ ALARM	☐ INCR	☐ OPEN	SET PT = _____	SET PT = _____	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET = _____	RESET = _____	
3	☐ ALARM	☐ INCR	☐ OPEN	SET PT = _____	SET PT = _____	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET = _____	RESET = _____	
4	☐ ALARM	☐ INCR	☐ OPEN	SET PT = _____	SET PT = _____	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET = _____	RESET = _____	

NOTE: PERM IS ABBREVIATION FOR PERMISSIVE

**ATTACHMENT D - TRANSMITTER/CONTROLLER/INDICATOR
INSTALLATION AND CALIBRATION CHECKLIST**

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

No Yes

INSTRUMENT TYPE
INDICATOR

☐ TRANSMITTER ☐ CONTROLLER ☐
☐ OTHER DESCRIPTION _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE
DESCRIPTION _____

<u>BENCH CALIBRATION CHECK</u>				
INPUT RANGE = _____			OUTPUT RANGE = _____	
HEAD CORRECTION = _____			☐ LINEAR	
CALIBRATED SPAN = _____			☐ SQUARE ROOT	
% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

CHECK BELOW, WHEN COMPLETED:

- ☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____
- ☐ VERIFIED PER P&ID NO. _____
- ☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____
- ☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____
- ☐ INSTALLATION CORRECT PER DETAIL NO. _____
- ☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED
- ☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL
- ☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

<u>FIELD CALIBRATION CHECK</u>				
INPUT RANGE = _____			OUTPUT RANGE = _____	
% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

- ☐ DIRECT ☐ REVERSE
- ☐ ACTION VERIFIED AT 50% SPAN
- ☐ ACTION VERIFIED AT _____ SPAN

CONTROLLER SETTINGS								
SETTING	GAIN	PB	RESET (INTEGRAL)	DERIV. (RATE)	HIGH LIMIT	LOW LIMIT	ELEV. ZERO	ZERO SUPP
PRE-TUNE								
POST-TUNE								

PRE-TUNE SETTINGS					
	GAIN	PB	RESET (REPEAT/MIN)	RESET (MIN/REPEAT)	DERIVATION (MINUTES)
FLOW	1.0	100	10	0.1	N/A
LEVEL	1.0	100	MIN.	MAX.	N/A
PRESSURE	2.0	50	2.0	0.5	N/A
TEMP.	4.0	25	0.1	10	OFF

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT E – ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST

	ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST	

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS? ☐ No ☐ Yes

TYPE OF INSTRUMENT _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, IF TRUE

- ☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____
- ☐ VERIFIED PER P&ID NO. _____
- ☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____
- ☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____
- ☐ INSTALLATION CORRECT PER DETAIL NO. _____
- ☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED
- ☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL
- ☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

**ATTACHMENT F - CONTROL VALVES
INSTALLATION AND CALIBRATION CHECKLIST**

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

No Yes

- ☐ VALVE TAG NO. _____ SERIAL NO. _____
- ☐ TRANSDUCER TAG NO. _____ SERIAL NO. _____
- ☐ SOLENOID TAG NO. _____ SERIAL NO. _____
- ☐ VOLUME BOOSTER TAG NO. _____ SERIAL NO. _____
- ☐ POSITIONER _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

TRANSDUCER CHECK					
INPUT RANGE =			OUTPUT RANGE =		
CALIBRATED SPAN =			CALIBRATED SPAN =		
BENCH					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		
FIELD					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		

CHECK BELOW, IF TRUE:

- ☐ BENCH CALIBRATED PER ABOVE _____
- ☐ VERIFIED PER P&ID NO. _____
- ☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____
- ☐ VALVE SPECIFICATION NO. _____
- ☐ TRANSDUCER SPECIFICATION NO. _____
- ☐ SOLENOID SPECIFICATION NO. _____
- ☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____
- ☐ INSTALLATION CORRECT PER INSTRUMENT INSTALLATION DETAILS _____
- ☐ VALVE DETAIL NO. _____
- ☐ TRANSDUCER DETAIL NO. _____
- ☐ SOLENOID DETAIL NO. _____

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

- ☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED
- ☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL
- ☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

VALVE CHECK			
FLOW CHECK	☐ PROCESS FLOW DIRECTION THROUGH THE VALVE IS CORRECT		
SAFETY CHECK	ON LOSS OF AIR VALVE FAILS ☐ OPEN ☐ CLOSE	ON LOSS OF POWER SOLENOID FAILS ☐ TO VENT ☐ TO VALVE	
TRAVEL CHECK	FULL OPEN AT _____ PSI	FULL CLOSED AT _____ PSI	MEASURED TRAVEL _____ INCHES
SEATING CHECK	☐ ON BENCH ☐ IN-LINE	RESULTS	ACTUATOR BENCH SET
POSITIONER CHECK			
VALVE FULL OPEN AT _____ PSI TO POSITIONER			
VALVE FULL CLOSED AT _____ PSI TO POSITIONER			
VOLUME BOOSTER CHECK			
BYPASS VALVE (GAIN) ADJUSTING SCREW BACKED OUT _____ TURNS FROM CLOSED TO ENSURE QUICK BUT STABLE OPERATION (TYPICALLY 1-1/2 TO 2 TURNS)			

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

Network Power SuppliesPower Supply Equipment

- ☐ ODVA compliant
☐ Quantity and ratings

Supply Source (120 VAC)

- ☐ Overcurrent protection
☐ Conductor size

Network Power Tap (24 VDC)

- ☐ Overcurrent protection
☐ Conductor size

Comments:

CHECKED BY (COMPANY)

ACCEPTED BY
(COMPANY)

SIGNATURE

SIGNATURE

DATE

DATE

SECTION 43_23_13.45

HORIZONTAL SELF-PRIMING SAMPLE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for provision of pump systems including self-priming centrifugal motor driven pumps are included.
- B. Tag numbers: As specified in Pump Schedule.

1.02 REFERENCES

- A. American Welding Society (AWS):
 - 1. D1.1 - Structural Welding Code - Steel.
- B. ASTM International (ASTM):
 - 1. A48 - Standard Specification for Gray Iron Castings.
 - 2. A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
 - 4. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - 5. A322 - Standard Specification for Steel Bars, Alloy, Standard Grades.
 - 6. A536 - Standard Specification for Ductile Iron Castings.
 - 7. A582 - Standard Specification for Free-Machining Stainless Steel Bars.
 - 8. A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 9. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 10. F594 - Standard Specification for Stainless Steel Nuts.
- C. Hydraulic Institute (HI):
 - 1. 9.1-9.5 - Pumps - General Guidelines.
 - 2. 14.1-14.2 - Rotodynamic Pumps for Nomenclature and Definitions.
 - 3. 14.3 - Rotodynamic Pumps for Design and Application.
 - 4. 14.6 - Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
- D. National Electrical Manufacturers Association (NEMA).

1.03 DEFINITIONS

- A. Pump head (Total Dynamic Head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr):
As defined in HI 9.1-9.5, 14.1-14.2, 14.3, 14.6 and as modified in this Section.

- B. Flow, head, efficiency, and driver horsepower specified in this Section are minimums unless stated otherwise.
- C. Allowable Operating Region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
- D. Preferred Operating Region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

1.04 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Vibration analysis: Submit as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment when scheduled.
- C. Product data: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- D. Shop drawings: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- E. Calculations: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- F. Vendor operation and maintenance manuals: As specified in Section 01_78_24 - Operation and Maintenance Manuals.
- G. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 - 2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.05 QUALITY ASSURANCE

- A. As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- B. Provide pumps specified in this Section from same manufacturer.
- C. Vibration analysis: Provide equipment vibration analysis as specified in this Section.
 - 1. Vibration analysis level: As scheduled and as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
 - 2. Vibration analysis expert: Provide when scheduled.
- D. Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.06 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Pumps:
 - 1. One of the following or equal:
 - a. Gorman-Rupp Company, AMT.
 - b. Barnes Pumps, similar to series listed.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Centrifugal self-priming pump with components: Pump, close coupled driver, bearings, seals, supports, anchor bolts, necessary valves, taps, and other items as required for a complete and operational system.
- B. Provide pumps, drivers, couplings, and other components capable of intermittent or continuous operation while pumping specified fluid; loss of prime and possible siphoning of liquid from the pump casing shall be considered in design of the self-priming features.
- C. Design requirements:
 - 1. Pump performance characteristics:
 - a. As specified in the Pump Schedule.
 - b. All required conditions (flow/head) shall be within the pump manufacturer's Allowable Operating Range (AOR).
 - c. Performance tolerances shall be the same as the test tolerances specified in Section 46_05_94 - Mechanical Equipment Testing.
 - 2. Motor characteristics: As specified in Pump Schedule.
- D. Product requirements as specified in Section 01_60_00 - Product Requirements and Section 46_05_10 - Common Work Results for Mechanical Equipment.

2.03 MATERIALS

- A. General: Materials in the Pump Schedule shall be the type and grade as specified in this Section.
- B. Cast iron: ASTM A48, Class 30 minimum.
- C. Ductile iron: ASTM A536, Grade as scheduled.
- D. 316 Stainless: ASTM A276, Type 316 stainless steel or ASTM A666, Type 316 Stainless Steel.
- E. 416 Stainless: ASTM A582, Type 416 stainless steel.

- F. Steel: ASTM A108, Grade as scheduled.
- G. Hot-wrought alloy steel: ASTM A322, Grade 4140, UNS Alloy G41400.
- H. Structural steel: ASTM A283, Grade D.

2.04 GENERAL PUMP CONSTRUCTION

- A. Type: Self-priming, centrifugal, sewage type pumps meeting performance and design requirements and features as specified in this Section.
- B. Fasteners: Provide Type 316 stainless steel fasteners in accordance with ASTM F593 and ASTM F594.

2.05 PUMP CASINGS

- A. Type: 1 or 2-piece.
- B. Material: Cast Iron.
- C. Construction: Of sufficient strength, weight, and thickness to provide accurate alignment, prevent excessive deflection, and support drive motor.
- D. NPT suction and discharge ports meeting design working pressure.
- E. Design internal suction check valve that can be removed through the cover plate. Check valve plate shall be constructed of neoprene.
- F. Hardware: Stainless steel.
- G. Maximum working pressure: 75 pound per square inch.
- H. Maximum temperature: 160 degrees Fahrenheit.
- I. Vent and taps:
 - 1. Provide castings with both 3/4-inch threaded low point and initial priming fill vent on casing. Install pipe nipples with threaded gate valves in drain and priming vent.

2.06 IMPELLERS

- A. Type: Self-cleaning, semi-open or open.
- B. Material: Bronze.
- C. Design with smooth water passages to prevent clogging by stringy or fibrous materials.
- D. Design impeller and volute for automatic unattended self-priming and repriming with a dry suction leg and without reliance on a suction check valve to maintain prime.

- E. Rotation: Clockwise looking from top, unless otherwise indicated on the Drawings.
- F. Balance: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment to meet vibration criteria as specified in Section 46_05_94 - Mechanical Equipment Testing.

2.07 SHAFT

- A. Material: Stainless steel.
- B. Strength: Able to withstand minimum 1.5 times maximum operating torque and other loads.
- C. Resonant frequency: As specified in Sections 46_05_10 - Common Work Results for Mechanical Equipment and 46_05_94 - Mechanical Equipment Testing.
- D. Deflection: Maximum 0.002 inches under operating conditions.
- E. Impeller attachment: Taper fitted at impeller with key and bolt for securing impeller.
- F. Pump shaft seal:
 - 1. Silicon carbide mechanical seal.
 - 2. Self-lubricating.

2.08 COUPLINGS

- A. Type: Close coupled.
- B. Flexible coupling life: Infinite at up to 0.3-degree misalignment angle total or per disk for disk type at maximum operating loads.
- C. Design coupling to withstand a minimum of 1.5 times the maximum operating torque and other imposed loads.

2.09 DRIVERS

- A. Horsepower:
 - 1. As scheduled.
 - 2. Listed driver horsepower is the minimum to be supplied.
 - a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.
 - b. However, electrical equipment is sized for scheduled horsepower.
- B. Motors: Provide motors as specified in Section 26_20_00 – Electrical Motors and as specified in this Section:
 - 1. Revolutions per minute: As scheduled.
 - 2. Enclosure: As scheduled.
 - 3. Electrical characteristics: As scheduled.

4. Efficiency, service factor, insulation, and other motor characteristics: As specified in Section 26_20_00 – Electrical Motors.
5. Motor accessories: As specified in Section 26_20_00 – Electrical Motors and in this Section.

2.10 ANCHOR BOLTS

- A. As specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.11 SPARE PARTS AND SPECIAL TOOLS

- A. Spare parts: None.
- B. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of all pump system components.

PART 3 EXECUTION

3.01 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and this Section.
- B. Manufacturer services:
 1. Certificates:
 - a. Manufacturer's Certificate of Source Testing.
 - b. Manufacturer's Certificate of Installation and Functionality Compliance.
 2. Process operational period:
 - a. As required by Owner or Contractor.
- C. Source testing: As specified in Pump Schedule.
- D. Functional testing: As specified in Pump Schedule.

3.02 PUMP SCHEDULE

Tag Numbers	SAM-1	SAM-2
<u>General Characteristics:</u>		
Service	Deep Zone Monitoring Well Sample Pump	Shallow Zone Monitoring Well Sample Pump
Quantity	1	1
Maximum Noise, dBA at 3 Feet	85	85
Minimum Pumped Fluid Degrees Fahrenheit	50	50
Normal Pumped Fluid Degrees Fahrenheit	70	70

Tag Numbers	SAM-1	SAM-2
Maximum Pumped Fluid Degrees Fahrenheit	85	85
Vibration Analysis Level	None	None
Vibration Analysis Expert	Not Required	Not Required
<u>Rated Design Point (at maximum Revolutions per Minute):</u>		
Flow, gpm	24	24
Head, Feet	263	202
<u>Other Conditions:</u>		
Maximum Shut Off Head, Feet	270	270
Minimum NPSHa at Every Specified Flow, Feet	TBD	TBD
Maximum Suction Static Lift, Feet	20	20
<u>Motor Characteristics (when motor is driver type):</u>		
Motor Specification Section	26_20_00 – Electrical Motors	26_20_00 – Electrical Motors
Motor Horsepower	10	10
Service Factor	1.15	1.15
Voltage/Phases/Hertz	230-460/3/60	230-460/3/60
NEMA Enclosure Type	TEFC	TEFC
<u>Source Testing:</u>		
Test Witnessing	Not Witnessed	Not Witnessed
Performance Test Level	None	None
Vibration Test Level	None	None
Noise Test Level	None	None
<u>Functional Testing:</u>		
Performance Test Level	1	1
Vibration Test Level	None	None
Noise Test Level	None	None

END OF SECTION

SECTION 43_25_00.10
SUBMERSIBLE PROCESS LIQUID SUMP PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Packaged submersible sump pumps, with a control panel and instrumentation.
- B. Tag numbers: As specified in Pump Schedule.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. A48 - Standard Specification for Gray Iron Castings.
 - 2. A276 - Standard Specification for Stainless Steel Bars and Shapes.
 - 3. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
- B. Hydraulic Institute (HI):
 - 1. 9.1-9.5 - Pumps - General Guidelines.
 - 2. 11.6 - Rotodynamic Submersible Pump Test.
 - 3. 14.1-14.2 - Rotodynamic Pumps for Nomenclature and Definitions.
 - 4. 14.3 - Rotodynamic Pumps for Design and Application.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

- A. NEMA:
 - 1. Type 4X enclosures in accordance with NEMA 250.
- B. Pump head (Total Dynamic Head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 9.1-9.5, 11.6, 14.1-14.2, 14.3 and as modified in this Section.
- C. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.
- D. Allowable Operating Region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

- E. Preferred Operating Region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

1.04 SUBMITTALS

- A. Submit as specified in Section 01_33_00 - Submittal Procedures.
- B. Product data: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- C. Shop drawings: As specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- D. Vendor operation and maintenance manuals: As specified in Section 01_78_24 - Operation and Maintenance Manuals.
- E. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01_75_17 - Commissioning.
 - 2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01_75_17 - Commissioning.

1.05 WARRANTY

- A. As specified in Section 01_78_36 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Components: Overhung impeller, close coupled, single stage, volute style, end suction submersible sewage pump. Other items include: Control panel, level control instrumentation, discharge piping, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.
- B. Design requirements:
 - 1. Pump performance characteristics: As specified in the Pump Schedule, Pump Performance Characteristics:
 - a. As specified in the Pump Schedule.
 - b. All required conditions (flow/head) shall be within the pump manufacturer's Preferred Operating Range (POR).
 - c. Performance tolerances shall be the same as the test tolerances specified in Section 46_05_94 - Mechanical Equipment Testing.
 - 2. Motor characteristics: As specified in the Pump Schedule.
- C. Product requirements as specified in Section 01_60_00 - Product Requirements and Section 46_05_10 - Common Work Results for Mechanical Equipment.

2.02 DEEP INJECTION WELL SUMP PUMP

- A. Manufacturers: One of the following or equal:
 - 1. Liberty Pumps, FL200-Series.
- B. Materials:
 - 1. Cast Iron: ASTM A48, Class 30 minimum.
 - 2. Stainless Steel: ASTM A276 or equal.
 - 3. Buna N: ASTM D2000.
- C. Pump casing:
 - 1. Material: Cast iron.
 - 2. Design Working Pressure: 1.5 times the shut off pressure.
 - 3. Provide support legs on sump bottom and clearance for suction entrance.
 - 4. The discharge connection shall be a 2 or 3-inch NPT vertical connection.
- D. Impellers:
 - 1. Material: Cast iron.
 - 2. 2-vane
- E. Pump shafts:
 - 1. Material: stainless steel.
- F. Bearings:
 - 1. Upper bearing: Single row; oil lubricated.
 - 2. Lower bearing: Single row; oil lubricated.
- G. Shaft seal:
 - 1. Single mechanical seal.
 - 2. Materials:
 - a. Silicon carbide versus silicon carbide seal faces.
 - b. Carbon versus ceramic seal faces.
 - 3. Elastomer and hardware: Buna-N and 300 series stainless steel.
- H. Finishes:
 - 1. Pump manufacturer to factory prime and coat

2.03 MONITORING WELL SUMP PUMP

- A. Manufacturers: The following or equal:
 - 1. Ebara
- B. Materials:
 - 1. Pump casing, base, and housing: Type 304L stainless steel.
 - 2. Fasteners: Type 304L stainless steel.
- C. Pump casing:
 - 1. Type: Air filled.
 - 2. Able to run dry or unsubmerged.
 - 3. Inspection plugs, drain plugs, and vent plugs: Manufacturer's standard.

- D. Impellers:
 - 1. Materials: Type 304 stainless steel.
 - 2. Type: Semi-open.
 - 3. Passage sizes: Large enough to pass solids with sphere size of 0.375 inches or smaller in diameter.
- E. Pump shafts:
 - 1. Material: Type 303 stainless steel.
- F. Bearings:
 - 1. Bearing types: Sealed.
- G. Shaft seal:
 - 1. Single mechanical seal.
 - 2. Face materials: Carbon and ceramic, or silicon carbide.
 - 3. Provide double mechanical seals, not damaged when pump is run dry or unsubmerged for extended periods.
- H. Finishes:
 - 1. Pump manufacturer to factory prime and coat pump/motor.

2.04 ACCESSORIES

- A. Accessories:
 - 1. Lifting chains or cables:
 - a. Material: stainless steel.
 - b. Attached to balance point of pump; suitable for lifting pump from sump; long enough to extend from sump cover or grating.

2.05 CONTROLS

- A. General:
 - 1. Provide a vendor control panel at each installation for control of the pumps, except as indicated on the pump schedule.

2.06 LEVEL SENSORS

- A. Type: Ball float as specified in Section 40_72_76 - Level Measurement: Switches.
- B. Cable Length: The length of the cable shall be equal to sump depth to the VCP plus 5 feet.

2.07 SPARE PARTS AND SPECIAL TOOLS

- A. Provide 1 spare monitoring well sump pump.
- B. Provide 1 spare injection well sump pump.
- C. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

PART 3 EXECUTION

3.01 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning and this Section.
- B. Manufacturer services:
 - 1. Provide certificates:
 - a. Manufacturer's Certificate of Source Testing.
 - b. Manufacturer's Certificate of Installation and Functionality Compliance.
- C. Source testing: As specified in Pump Schedule.
- B. Functional testing: As specified in Pump Schedule.

3.02 PUMP SCHEDULE

- A. Pump characteristics:

Tag Numbers	SP-1, SP-2	SP-3
<u>General Characteristics</u>		
Location	DIW Sump	Monitoring Well Sump
Service	Sump Pump	Sump Pump
<u>Rated Design Point (At Maximum Revolutions per Minute):</u>		
Flow, Gallons per Minute	30	50
Head, Feet	106	15
<u>Other Conditions:</u>		
Min. Shutoff Head, feet	125	25
<u>Motor Characteristics:</u>		
Minimum Motor Horsepower	2	1/2
Motor Speed, revolutions per minute	3450	3450
<u>Vendor Control Panel</u>		
Required	No	No
Operation	NA	NA
<u>Source Testing:</u>		
Performance Test Level	1	1
<u>Functional Testing:</u>		
Performance Test Level	1	1

END OF SECTION

SECTION 46_05_10

COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Basic design and performance requirements for building mechanical equipment and process mechanical equipment.

1.02 REFERENCES

- A. American Gear Manufacturer's Association (AGMA) Standards:
 - 1. 6001-E08 - Design and Selection of Components for Enclosed Gear Drives.
- B. American Bearing Manufacturers Association (ABMA) Standards:
 - 1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. American Petroleum Institute (API):
 - 1. 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.
- D. ASTM International (ASTM):
 - 1. A36 - Standard Specification for Carbon Structural Steel.
 - 2. A48 - Standard Specification for Gray Iron Castings.
 - 3. A125 - Standard Specification for Steel Springs, Helical, Heat-Treated.
 - 4. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - 5. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 6. A320 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
 - 7. A536 - Standard Specification for Ductile Iron Castings.
 - 8. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 9. B61 - Standard Specification for Steam or Valve Bronze Castings.
 - 10. B62 - Standard specification for Composition Bronze or Ounce Metal Castings.
 - 11. B505 - Standard Specification for Copper Alloy Continuous Castings.
 - 12. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 14. F594 - Standard Specification for Stainless Steel Nuts.

- E. Hydraulic Institute (HI).
- F. Occupational Safety and Health Administration (OSHA).
- G. Unified Numbering System (UNS).

1.03 DEFINITIONS

- A. Resonant frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.
- B. Rotational frequency: The revolutions per unit of time usually expressed as revolutions per minute.
- C. Critical frequency: Same as resonant frequency for the rotating elements or the installed machine and base.
- D. Peak vibration velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.
- E. Rotational speed: Same as rotational frequency.
- F. Maximum excitation frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.
- G. Critical speed: Same as critical frequency.
- H. Free field noise level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.
- I. Operating weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 SUBMITTALS

- A. As specified in Section 01_60_00 - Product Requirements.
- B. Product data:
 - 1. For each item of equipment:
 - a. Design features.
 - b. Load capacities.
 - c. Efficiency ratings.
 - d. Material designations by UNS alloy number or ASTM Specification and Grade.
 - e. Data needed to verify compliance with the Specifications.
 - f. Catalog data.
 - g. Nameplate data.
 - h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

2. Gear reduction units:
 - a. Engineering information in accordance with applicable AGMA standards.
 - b. Gear mesh frequencies.
- C. Shop drawings:
 1. Drawings for equipment:
 - a. Drawings that include cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
 2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, base plate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
 3. Installation instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial Installation Testing procedures.
 4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.
 5. Recommended or normal operating parameters such as temperatures and pressures.
 6. Alarm and shutdown setpoints for all controls furnished.
- D. Calculations:
 1. Structural:
 - a. Substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design requirements specified and seismic design criteria as specified in Section 01_81_50 - Design Criteria.
 2. Mechanical:
 - a. ABMA 9 or ABMA 11 L10 life for bearings calculation methods for drivers, pumps, gears, shafts, motors, and other driveline components with bearings.
 - b. Substantiate that operating rotational frequencies meet the requirements of this Section.
 - c. Torsional analysis of power transmission systems: When torsional analysis specified in the equipment sections, provide:
 - 1) Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
 - 2) Results of analysis including first and second critical frequencies of system components and complete system.
 - d. Calculations shall be signed and stamped by a licensed engineer.
 3. Drinking water:
 - a. If applicable, conform to the requirements of Section 01_60_00 - Product Requirements for materials in contact with drinking water.
- E. Operation and maintenance manuals:
 1. As specified in Section 01_78_24 - Operating and Maintenance Manuals.
 2. Equipment with bearings:
 - a. Include manufacturer and model number of every bearing.
 - b. Include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.

- F. Commissioning submittals: As specified in Section 01_75_17 - Commissioning.
- G. Project closeout documents: As specified in Section 01_77_00 - Closeout Procedures.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. General:
 - 1. Product requirements as specified in Section 01_60_00 - Product Requirements.
 - 2. Project conditions as specified in Section 01_81_50 - Design Criteria.
 - 3. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions specified in this Section.
 - 4. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
 - 5. Vibration considerations:
 - a. Resonant frequency:
 - 1) For single-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
 - 2) For variable-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the range of operating frequencies.
 - b. Design, balance, and align equipment to meet the vibration criteria specified in Section 46_05_94 - Mechanical Equipment Testing.
 - 6. Equipment units weighing 50 pounds or more: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.
- B. Power transmission systems:
 - 1. V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a service factor of 1.5 or greater in accordance with manufacturer recommendations:
 - a. Apply service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
 - b. Apply service factors in accordance with AGMA 6001-E08, other applicable AGMA standards, or other applicable referenced standards.
- C. Equipment mounting and anchoring:
 - 1. Mount equipment on cast-iron or welded-steel bases with structural steel support frames.
 - a. Utilize continuous welds to seal seams and contact edges between steel members.

- b. Grind welds smooth.
- 2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
- 3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
- 4. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load specified in Section 01_81_50 - Design Criteria, and other loads as required for proper operation of equipment.
 - a. For equipment with an operating weight of 400 pounds or greater and all equipment that is supported higher than 4 feet above the floor, provide calculations for:
 - 1) The operating weight and location of the centroid of mass for the equipment.
 - 2) Forces and overturning moments.
 - 3) Shear and tension forces in equipment anchorages, supports, and connections.
 - 4) The design of equipment anchorage, supports, and connections based on calculated shear and tension forces.
- 5. Anchorage of equipment to concrete or masonry:
 - a. Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
 - b. Unless otherwise indicated on the Drawings, select and provide anchors from the types specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry.
 - c. Provide bolt sleeves around cast-in anchor bolts for 400 pounds or greater equipment.
 - 1) Adjust bolts to final location and secure the sleeve.
- 6. Anchorage of equipment to metal supports:
 - a. Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
- 7. Unless otherwise indicated on the Drawings, install equipment supported on concrete over non-shrink grout pads as specified in this Section.

2.02 MATERIALS

- A. Materials as specified in Section 01_60_00 - Product Requirements including special requirements for materials in contact with drinking water.
- B. Ferrous materials:
 - 1. Steel for members used in fabrication of assemblies: ASTM A36.
 - 2. Iron castings: ASTM A48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
 - 3. Ductile iron castings: ASTM A536, Grade 65-45-12, free from flaws and imperfections.
 - 4. Galvanized steel sheet: ASTM A653, minimum 0.0635-inch (16-gauge).
 - 5. Expanded metal: ASTM A36, 13-gauge, 1/2-inch flat pattern expanded metal.
 - 6. Stainless steel:
 - a. As specified in Section 40_05_23.01 – Stainless Steel Pipe.

- b. In contact or within 36 inches of water: Type 316 or 316L.
 - c. In sea air environment: Type 316 or 316L.
- C. Non-ferrous materials:
 - 1. Bronze in contact with drinking water: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C89833, C89520, or C92200 in accordance with ASTM B61, B62, B505, or B584, when not specified otherwise.
 - 2. Bronze in contact with wastewater: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C89833, C89520, C92200, or C93700 in accordance with ASTM B61, B62, B505, or B584, when not specified otherwise.
 - 3. Aluminum: As specified in Section 05_14_05 - Structural Aluminum.
- D. Dielectric materials for separation of dissimilar metals:
 - 1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials as specified.
- E. Non-shrink grout and epoxy non-shrink grout: As specified in Section 03_60_00 - Grouting.

2.03 ANCHORS AND FASTENERS

- A. Mechanical anchoring to concrete and masonry:
 - 1. As specified in Section 05_05_24 - Mechanical Anchoring and Fastening to Concrete and Masonry:
 - a. Type 316 stainless steel.
 - 2. Design as specified in Section 01_81_50 - Design Criteria.
- B. Flange bolts:
 - 1. As specified in Section 40_05_00.01 - Common Work Results for General Piping.
- C. Mechanical assembly fasteners:
 - 1. Stainless steel:
 - a. High-temperature service or high-pressure service:
 - 1) Bolts: ASTM A193, Grade B8 (Type 304) or Grade B8M (Type 316), Class 1, heavy hex.
 - 2) Nuts: ASTM A194, Grade 8, heavy hex.
 - 3) Washers: Alloy group matching bolts and nuts.
 - b. Low-temperature service:
 - 1) Bolts: ASTM A320, Grade B8 (Type 304) or Grade B8M (Type 316), Class 1, heavy hex.
 - 2) Nuts: ASTM A194, Grade 8 (Type 304) or Grade B8M (Type 316), heavy hex.
 - 3) Washers: Alloy group matching bolts and nuts.
 - c. General service:
 - 1) Bolts: ASTM F593, Alloy Group 1 (Type 304) or Alloy Group 2 (Type 316).

- 2) Nuts: ASTM F594, Alloy Group 1 (Type 304) or Alloy Group 2 (Type 316).
- 3) Washers: Alloy group matching bolts and nuts.

2.04 SHAFT COUPLINGS

- A. General:
 1. Type and ratings: Provide non-lubricated type, designed for not less than 50,000 hours of operating life.
 2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.
- B. Shaft couplings for close-coupled electric-motor-driven equipment:
 1. Use for:
 - a. Equipment 1/2 horsepower or larger.
 - b. Reversing equipment.
 - c. Equipment subject to sudden torque reversals or shock loading:
 - d. Examples:
 - 1) Reciprocating pumps, blowers, and compressors.
 - 2) Conveyor belts.
 2. Manufacturers: One of the following or equal:
 - a. Lovejoy.
 - b. T.B. Woods.
 3. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
 4. Manufacture flexible component of coupling from synthetic rubber or urethane.
 5. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
 6. Do not allow metal-to-metal contact between driver and driven equipment.
- C. Shaft couplings for direct-connected electric-motor-driven equipment:
 1. Use for 1/2 horsepower or larger and subject to normal torque, non-reversing applications.
 2. Manufacturers: One of the following or equal:
 - a. Rexnord.
 - b. T.B. Woods.
 3. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
 4. Provide flexible connecting element of rubber and reinforcement fibers.
 5. Provide service factor of 2.0.
 6. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.
- D. Spacer couplings: Where cartridge-type mechanical seals or non-split seals are specified, provide a spacer-type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.
- E. Specialized couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer:
 1. Includes any engine-driven equipment.

2.05 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:

1. Unless otherwise noted in the equipment section, provide cartridge-type, double mechanical shaft seals for pumps.
2. Provide a stuffing box large enough for a double mechanical seal.
3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
4. Provide seal or packing flush connections, (3/4-inch size unless another size is indicated on the Drawings).
5. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
6. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
7. Seal or packing flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
 - a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
 - b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
 - c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
 - d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water).
 - e. Double seal applications: Plan 54 (External seal water).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:

1. Wastewater, water, and sludge applications:
 - a. Asbestos free.
 - b. PTFE (Teflon™) free.
 - c. Braided graphite.
 - d. Manufacturers: One of the following or equal:
 - 1) Chesterton, 1400.
 - 2) John Crane, equivalent product.
2. Drinking water service:
 - a. Asbestos free.
 - b. Material: Braided PTFE (Teflon™).
 - c. Manufacturers: One of the following or equal:
 - 1) Chesterton, 1725.
 - 2) John Crane, equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified.

1. Provide seal types meeting the following requirements:
 - a. Balanced hydraulically.
 - b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
 - c. O-ring: Viton™ 747.
 - d. Gland: Type 316L stainless steel.

- e. Set screws: Type 316L stainless steel.
- f. Faces: Reaction bonded, silicon carbide.
- g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.
- 2. Cartridge-type single mechanical:
 - a. Manufacturers: One of the following or equal:
 - 1) Chesterton, S10.
 - 2) John Crane, 5610 Series.
- 3. Cartridge-type double mechanical: Manufacturers:
 - a. One of the following or equal:
 - 1) Chesterton, S20.
 - 2) John Crane, 5620 Series.
- 4. Split-face single mechanical: Manufacturers:
 - a. One of the following or equal:
 - 1) Chesterton, 442.
 - 2) John Crane, 3740.

2.06 GEAR REDUCTION UNITS

- A. Type: Helical or herringbone, unless otherwise specified.
- B. Design:
 - 1. Made of alloys treated for hardness and for severe service.
 - 2. AGMA Class II service:
 - a. Use more severe service condition when such is recommended by unit's manufacturer.
 - 3. Cast-iron housing with gears running in oil.
 - 4. Anti-friction bearings.
 - 5. Thermal horsepower rating based on maximum horsepower rating of prime mover, not actual load.
 - 6. Manufactured in accordance with applicable AGMA standards.
- C. Planetary gear units are not to be used.

2.07 BELT DRIVES

- A. Sheaves:
 - 1. Separately mounted on bushings by means of at least 3 pull-up bolts or cap tightening screws.
 - 2. When 2 sheave sizes are specified, provide separate belts sized for each set of sheaves.
 - 3. Statically balanced for all; dynamically balanced for sheaves that operate at a peripheral speed of more than 5,500 feet per minute.
 - 4. Key bushings to drive shaft.
- B. Belts: Anti-static type when explosion-proof equipment or environment is specified.
 - 1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit:
 - a. Where 2 or more belts are involved, furnish matched sets.

- b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
 - c. Package in boxes labeled with identification of contents.
- C. Manufacturers: One of the following or equal:
 - 1. Dodge, Dyna-V belts with matching Dyna-V sheaves and Taper-Lock bushings.
 - 2. T.B. Woods, Ultra-V belts with matching Sure-Grip sheaves and Sure-Grip bushings.

2.08 BEARINGS

- A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.
- B. Oil-lubricated bearings: Provide either pressure lubricating system or separate oil reservoir splash-type system:
 - 1. Size oil-lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the temperature 15 degrees Fahrenheit above the maximum design temperature as specified in Section 01_81_50 - Design Criteria.
 - 2. Provide an external oil cooler when required to satisfy the specified operating conditions:
 - a. Provide air-cooled system if a water-cooling source is not indicated on the Drawings.
 - b. Equip oil cooler with a filler pipe and external level gauge.
- C. Grease lubricated bearings, except those specified to be factory sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
 - 1. Lubrication lines and fittings:
 - a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
 - b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
 - c. Use standard hydraulic-type grease supply fittings:
 - 1) Manufacturers: One of the following or equal:
 - a) Alemite.
 - b) Zerk.
- D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 L10 life for bearings rating life of not less than 50,000 hours.

2.09 MOTORS

- A. As specified in Section 26_20_00 – Electric Motors.

2.10 GEAR MOTORS

- A. Motors as specified in Section 26_20_00 – Electric Motors.
- B. Helical gearing for parallel shaft drives and worm gearing for right-angle drives.

- C. Manufactures: One of the following or equal:
 - 1. Baldor Electric Company.
 - 2. Bodine Electric Company.

2.11 VENDOR CONTROL PANELS

- A. As specified in Section 40_67_01 - Control Systems: Panels, Enclosures and Panel Components.

2.12 EQUIPMENT SUPPORT FRAMES

- A. Bolt holes shall not exceed bolt diameter by more than 25 percent, up to a limiting maximum diameter oversize of 1/4-inch.

2.13 PIPING AND VALVES

- A. Piping as specified in Section 40_05_00.01 - Common Work Results for General Piping.
- B. Valves as specified in Section 40_05_51.01 - Common Work Results for Valves.

2.14 SAFETY EQUIPMENT

- A. Safety guards:
 - 1. Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.
 - 2. Requirements:
 - a. Allow visual inspection of moving parts without removal.
 - b. Allow access to lubrication fittings.
 - c. Prevent entrance of rain or dripping water for outdoor locations.
 - d. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.
 - 3. Materials:
 - a. Sheet metal: Carbon steel, 12-gauge minimum thickness, hot-dip galvanized after fabrication.
 - b. Fasteners: Type 304 stainless steel.
- B. Insulation:
 - 1. Insulate all surfaces with normal operating temperatures above 120 degrees Fahrenheit when surface is within 7.5 feet height from any operating floor or level.
 - 2. Insulation thickness such that temperature is below 120 degrees Fahrenheit.
 - 3. Insulation Type 3 and cover Type 5.
- C. Warning signs:
 - 1. Provide warning signs in accordance with OSHA requirements for equipment that starts automatically or remotely.
 - 2. Material, sign size, and text: As specified on Drawings.
 - 3. Mount warning signs with stainless steel fasteners at equipment.

2.15 NAMEPLATES

- A. Fastened to equipment at factory in an accessible and visible location.
- B. Stainless steel sheet engraved or stamped with text, holes drilled or punched for fasteners.
- C. Fasteners: Number 4 or larger oval head stainless steel screws or drive pins.
- D. Text:
 - 1. Manufacturer's name, equipment model number and serial number, motor horsepower when appropriate, and identification tag number.
 - 2. Indicate the following additional information as applicable:
 - a. Maximum and normal rotating speed.
 - b. Service class per applicable standards.
 - 3. Include for pumps:
 - a. Rated total dynamic head in feet of fluid.
 - b. Rated flow in gallons per minute.
 - c. Impeller, gear, screw, diaphragm, or piston size.
 - 4. Include for gear reduction units:
 - a. AGMA class of service.
 - b. Service factor.
 - c. Input and output speeds.

2.16 SHOP FINISHES

- A. Provide appropriate factory coatings as specified in Section 09_96_01 - High-Performance Coatings.
 - 1. Motors and gear reducers: Shop finish paint with manufacturer's standard coating, unless otherwise specified in the individual equipment specification.

2.17 SPECIAL TOOLS

- A. Supply 1 set of special tools as specified in Section 01_60_00 - Product Requirements.

2.18 SOURCE TESTING

- A. Testing requirements unless specified otherwise in the individual equipment specifications:
 - 1. Mechanical equipment: Level 1 General Equipment Performance Test as specified in Section 46_05_94 - Mechanical Equipment Testing.
 - 2. Motors: As specified in Section 26_20_00 – Electric Motors.
 - 3. Vendor control panels: As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

2.19 SHIPPING

- A. As specified in Section 01_60_00 - Product Requirements.
- B. Prior to shipment of equipment:
 - 1. Bearings (and similar items):
 - a. Pack separately or provide other protection during transport.
 - b. Greased and lubricated.
 - 2. Gear boxes:
 - a. Oil filled or sprayed with rust preventive protective coating.
 - 3. Fasteners:
 - a. Inspect for proper torques and tightness.

PART 3 EXECUTION

3.01 DELIVERY, HANDLING, STORAGE, AND PROTECTION

- A. As specified in Section 01_60_00 - Product Requirements.
- B. Inspect fasteners for proper torques and tightness.
- C. Storage:
 - 1. Bearings:
 - a. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
 - 2. Gear boxes:
 - a. Inspect to verify integrity of protection from rust.
- D. Protection:
 - 1. Equipment Log shall include description of rotation performed as part of maintenance activities.

3.02 INSTALLATION

- A. Field measurements:
 - 1. Prior to shop drawings preparation, take measurements and verify dimensions indicated on the Drawings.
 - 2. Ensure equipment and ancillary appurtenances fit within available space.
- B. Sequencing and scheduling:
 - 1. Equipment anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place.
 - 2. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

- C. Metal work embedded in concrete:
 - 1. Accurately place and hold in correct position while concrete is being placed.
 - 2. Clean surface of metal in contact with concrete immediately before concrete is placed.
- D. Concrete surfaces designated to receive non-shrink grout:
 - 1. Heavy sandblast concrete surface in contact with non-shrink grout.
 - 2. Clean concrete surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bond to non-shrink grout.
 - 3. Saturate concrete with water. Concrete shall be saturated surface damp at time non-shrink grout is placed.
- E. Install equipment in accordance with manufacturer's installation instructions and recommendations.
- F. Lubrication lines and fittings:
 - 1. Support and protect lines from source to point of use.
 - 2. Fittings:
 - a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
 - b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
 - c. Fittings for underwater bearings: Bring fittings above water surface and mount on edge of structure above.
- G. Alignment of drivers and equipment:
 - 1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
 - 2. Comply with procedures of appropriate HI, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
 - a. Maximum total coupling offset (not the per-plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).
 - b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.
 - 3. Use reverse-indicator arrangement dial-type or laser-type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
 - 4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation, and axial spacing tolerances of the coupling.
 - 5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation.
 - a. Allow minimum 48 hours for grout to harden.

- b. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment.
 - c. Correct alignment as required.
 - 6. After functional testing is complete, dowel motor or drivers and driven equipment:
 - a. Comply with manufacturer's instructions.
- H. Grouting under equipment bases, baseplates, soleplates, and skids:
 - 1. Unless otherwise indicated on the Drawings, grout with non-shrink grout as specified in Section 03_60_00 - Grouting.
 - a. Non-shrink epoxy grout required only when indicated on the Drawings.
 - 2. Comply with equipment manufacturer's installation instructions for grouting spaces, and tolerances for level and vertical and horizontal alignment.
 - 3. Install grout only after:
 - a. Equipment is leveled and in proper alignment.
 - b. Piping connections are complete and in alignment with no strain transmitted to equipment.
 - 4. Do not use leveling nuts on equipment anchors for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting.
 - 5. Use jack screws for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting following the procedure defined below:
 - a. Drill and tap equipment base plates, sole plates, and skids for jack screws.
 - b. Use suitable number and size of jack screws.
 - c. End of jack screws shall bear on circular steel plates epoxy bonded to equipment foundation.
 - d. Jack screw threads that will be in contact with grout: Wrap with multiple layers of tape or other material, acceptable to Engineer, to prevent grout from bonding to threads.
 - e. Place and cure grout as specified in Section 03_60_00 - Grouting.
 - f. After grout is cured, remove jack screws and material used to prevent bonding to grout.
 - 1) Provide jack screws to Owner for future use.
 - g. Tighten equipment anchors in accordance with equipment manufacturer requirements.
 - h. Fill holes where jack screws have been removed with grout.
 - i. Cure as specified in Section 03_60_00 - Grouting.
 - 6. For equipment bases, baseplates, soleplates, and skids where it is not practical to use jack screws, use steel wedges and shims.
 - a. Wrap wedges and shims that contact grout with multiple layers of tape or other material, acceptable to Engineer, to prevent grout from bonding.
 - b. Place and cure grout as specified in Section 03_60_00 - Grouting.
 - c. Remove wedges or shims.
 - d. Tighten equipment anchors to in accordance with equipment manufacturer requirements.
 - e. Fill voids where wedges and shims have been removed with grout.
 - f. Cure as specified in Section 03_60_00 - Grouting.
 - 7. Preparation of equipment bases, baseplates, soleplates, and skids for grouting:
 - a. Metal in contact with grout: Grit blast to white metal finish.

- b. Clean surfaces of equipment bases, baseplates, soleplates, and skids in contact with grout of dirt, dust, oil, grease, paint, and other material that will reduce bond.
 - 8. Preparation of concrete equipment foundation for grouting:
 - a. Rough concrete surfaces in contact with grout.
 - b. Concrete contact surface shall be free of dirt, dust, laitance, particles, loose concrete, or other material or coatings that will reduce bond.
 - c. Saturate concrete contact surface area with water for minimum of 24 hours prior to grouting.
 - d. Remove standing water just prior to grout placement, using clean rags or oil-free compressed air.
 - 9. Forms and header boxes:
 - a. Build forms for grouting of material with adequate strength to withstand placement of grouts.
 - b. Use forms that are rigid and liquid tight. Caulk cracks and joints with an elastomeric sealant.
 - c. Line forms with polyethylene film for easy grout release. Forms carefully waxed with 2 coats of heavy-duty paste wax will also be acceptable.
 - 10. Grout placement requirements:
 - a. Minimum ambient and substrate temperature: 45 degrees Fahrenheit and rising:
 - 1) Conform to grout manufacturer's temperature requirements.
 - b. Pour grout using header box.
 - c. Keep level of grout in header box above bottom of equipment bases, baseplates, soleplates, and skids at all times to prevent air entrapment.
 - d. Grout shall flow continuously from header box to other side of forms without trapping air or forming voids.
 - e. Vibrate, rod, or chain grout to facilitate grout flow, consolidate grout, and remove entrapped air.
 - f. After grout sets, remove forms and trim grout at 45-degree angle from bottom edge of equipment bases, baseplates, soleplates, and skids.
 - g. Cure as specified in Section 03_60_00 - Grouting.
- I. Field welding:
 - 1. Use welding procedures, welders, and welding operators qualified and certified in accordance with AWS D1.1.
 - 2. Shielded arc welding.
- J. Field finishes:
 - 1. Protect motors.
 - 2. Clean equipment.
 - 3. Apply primer and coating systems as specified in Section 09_96_01 - High-Performance Coatings requirements.
- K. Special techniques:
 - 1. Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

- L. Tolerances:
 - 1. Completed equipment installations: Comply with requirements for intended use and specified vibration and noise tolerances.
- M. Warning signs:
 - 1. Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.03 COMMISSIONING

- A. As specified in Section 01_75_17 - Commissioning.
- B. Functional testing requirements unless specified otherwise in the individual equipment specifications:
 - 1. Mechanical equipment: Level 1 tests as specified in Section 46_05_94 - Mechanical Equipment Testing.
 - 2. Motors: As specified in Sections 26_20_00 – Electric Motors and 26_08_00 – Electrical Testing.
 - 3. Vendor control panels: As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

END OF SECTION

SECTION 46_05_94
MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Testing of mechanical equipment and systems.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. S1.4 Specification for Sound Level Meters.
- B. Hydraulic Institute (HI).
- C. National Institute of Standards and Technology (NIST).

1.03 SUBMITTALS

- A. Provide Source Test Plans as specified in Section 01_75_17 - Commissioning.
- B. Provide Installation and Functional Testing Plans as specified in Section 01_75_17 - Commissioning.
- C. Provide vendor operation and maintenance manual as specified in Section 01_78_24 - Operation and Maintenance Manuals.
 - 1. Include motor rotor bar pass frequencies for motors larger than 500 horsepower.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Commissioning of equipment as specified in:
 - 1. This Section.
 - 2. Section 01_75_17 - Commissioning.
 - 3. Equipment sections:
 - a. If testing requirements are not specified, provide Level 1 Tests.
- B. Test and prepare piping as specified in Section 40_05_00.09 - Piping Systems Testing prior to equipment testing.

- C. Provide necessary test instrumentation that has been calibrated within 1 year from date of test to recognized test standards traceable to the NIST or approved source.
 - 1. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for tests.
 - 2. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.
- D. Test measurement and result accuracy:
 - 1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments.
 - a. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
 - 2. Do not adjust results of tests for instrumentation accuracy.
 - a. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

3.02 PUMP TESTS, ALL LEVELS OF TESTING

- A. Test in accordance with the following:
 - 1. Applicable HI Standards.
 - 2. This Section.
 - 3. Equipment sections.
- B. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
 - 1. From 0 to plus 5 percent of head at the rated design point flow.
 - 2. From 0 to plus 5 percent of flow at the rated design point head.
 - 3. No tolerance for head and flow when ranges are specified.
 - 4. No negative tolerance for the efficiency at the rated design point, and other specified conditions.
 - 5. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

3.03 DRIVERS TESTS

- A. Test motors as specified in Section 26_20_00 – Electric Motors.
- B. Test other drivers as specified in the equipment section.

3.04 NOISE REQUIREMENTS AND CONTROL

- A. Perform noise tests in conjunction with vibration test analysis.
- B. Make measurements in relation to reference pressure of 0.0002 microbar.
- C. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

- D. Set sound level meter to slow response.
- E. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.05 PRESSURE TESTING

- A. Hydrostatically pressure test pressure containing parts at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher.

3.06 INSPECTION AND BALANCING

- A. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits.
- B. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.
- C. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.
- D. Critical speed of rotating equipment:
 - 1. Satisfy the following:
 - a. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
 - b. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
 - c. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.
- E. Vibration tests:
 - 1. Definitions:
 - a. Root mean square: for pumps operating at speeds greater than 600 rpm, the vibration measurement shall be measured as the overall velocity in inches per second root mean square (RMS).
 - b. Peak-to-peak displacement: The root means squared average of the peak-to-peak displacement multiplied by the square root of 2.
 - c. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
 - d. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.

- e. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
 - 1) Manufacturers: One of the following or equal:
 - a) Rockwell Automation, Entek Group, "Spike Energy" analysis.
 - b) CSI, "PeakVue."
 - f. Rotor bar pass frequency (RBF), for detecting loose rotor bars.
 - g. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
 - h. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.
 - i. Preferred operating range: Manufacturer's defined preferred operating range (POR) for the equipment.
 - j. Allowable operating range: Manufacturer's defined allowable operating range (AOR) for the equipment.
2. Vibration instrumentation requirements:
- a. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12-bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high-frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
 - 1) Manufacturers: One of the following or equal:
 - a) Computational Systems Inc., (CSI) Division of Emerson Process Management, Model 2120A, Data Collector/analyzer with applicable analysis software.
 - b) Pruftechnik, VIBXPERT II.
 - b. Analyzer settings:
 - 1) Units: English, inches/second, mils, and gravitational forces.
 - 2) Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
 - 3) Sample averages: 4 minimum.
 - 4) Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
 - 5) Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
 - 6) Fast fourier transform windowing: Hanning Window.
 - 7) High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

- c. Accelerometers:
 - 1) For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
 - a) Manufacturers: One of the following or equal:
 - (1) Wilcoxon Research, Model 797L.
 - (2) PCB, Model 393C.
 - 2) For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.
 - a) Manufacturers: One of the following or equal:
 - (1) Wilcoxon Research, Model 793.
 - (2) Entek-IRD Model 943.
- 3. Accelerometer mounting:
 - a. Use magnetic mounting or stud mounting.
 - b. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
 - c. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.
- 4. Vibration acceptance criteria:
 - a. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.
 - b. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Conditions and Application Data	Overall Peak-to-Peak Displacement	
	Field, mils	Factory, mils
Operation within the POR	3.0	4.0
Operation within the AOR	4.0	5.0
Additive value when measurement location is greater than 5 feet above foundation.	2.0	2.0
Additive value for solids-handling pumps	2.0	N/A
Additive value for slurry pumps	2.0	N/A

- c. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Horizontal Solids Handling Centrifugal Pumps	Below 33 hp	0.25	0.28
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type) Vertical Solids Handling Centrifugal Pumps	Between 33 and 100 hp	0.28	0.31
	100 hp and above	0.31	0.34
	Below 33 hp	0.30	0.33
Vertical Turbine, Mixed Flow, and Propeller Pumps (solids-handling type pumps)	Between 33 and 100 hp	0.32	0.35
	100 hp and above	0.34	0.35
Non-Solids Handling Centrifugal Pumps HI Types BB1, BB2, BB3, BB4, BB5, OH1, OH2, OH3, OH4, OH5, and OH7	Below 268 hp	0.15	0.19
	268 hp and above	0.19	0.22
Vertical Turbine, Mixed Flow, and Propeller Pumps HI Types VS1, VS2, VS3, VS4, VS5, VS6, VS7, and VS8	Below 268 hp	0.13	
	268 hp and above	0.17	
Slurry Pumps		0.25	0.30
Motors		See Applicable Motor Specification	See Applicable Motor Specification
Gear Reducers, Radial		Not to exceed AGMA 6000-B96 limits	Not to exceed AGMA 6000-B96 limits
Other Reducers, Axial		0.1	N/A

- d. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.
- e. Additional criteria:
 - 1) No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.

- 2) The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
 - 3) For motors, the following shall be cause for rejection:
 - a) Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that is more than 40 percent of the peak at rotational frequency.
 - b) Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.
 - c) Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
 - d) Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.
 - 4) The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.
5. Vibration testing results presentation:
- a. Provide equipment drawing with location and orientation of measurement points indicated.
 - b. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
 - c. When Vibration Spectra Data required:
 - 1) Plot peak vibration velocity versus frequency in cycles per minute.
 - 2) Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
 - 3) Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
 - 4) Plot motor spectra on a log amplitude scale versus frequency.
 - d. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
 - e. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.07 TESTING LEVELS

A. Level 1 Tests:

1. Level 1 Performance Test:

a. General:

- 1) For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
- 2) Operate at rated design load conditions.
- 3) Confirm that equipment is properly assembled.
- 4) Confirm the equipment moves or rotates in the proper direction.
- 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
- 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

b. Pumps:

- 1) Comply with general performance test requirements as specified in this Section.
- 2) Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
 - a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_20_00 – Electric Motors or the applicable equipment section.
 - b) Use actual driver for field tests.
- 3) Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.

2. Level 1 Vibration Test:

a. Test requirement:

- 1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
- 2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.

b. Equipment operating condition: Test at specified maximum speed.

3. Level 1 Noise Test:

- a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Tests:

1. Level 2 Performance Test:

a. General:

- 1) For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.

- 2) Operate at rated design load conditions.
- 3) Confirm that equipment is properly assembled.
- 4) Confirm the equipment moves or rotates in the proper direction.
- 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
- 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
- b. Pumps:
 - 1) Comply with general performance test requirements as specified in this Section.
 - 2) Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
 - a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_20_00 – Electric Motors.
 - b) Use actual driver for field tests.
 - 3) Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
 - 4) Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.
2. Level 2 Vibration Test:
 - a. Test requirement:
 - 1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
 - 2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
 - b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
 - c. Natural frequency test of field installed equipment:
 - 1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears, and supports.
 - 2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.

- 3) Perform with equipment and attached piping full of intended service or process fluid.
 3. Level 2 Noise Test:
 - a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.
- C. Level 3 Tests:
 1. Level 3 Performance Tests:
 - a. General:
 - 1) For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
 - 2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
 - 3) Confirm that equipment is properly assembled.
 - 4) Confirm the equipment moves or rotates in the proper direction.
 - 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
 - 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
 - 7) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure, and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
 - 8) Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.
 - b. Pumps:
 - 1) Comply with general performance test requirements as specified in this Section.
 - 2) Test 4 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test at full speed.
 - a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_20_00 – Electric Motors.
 - b) Use actual driver for field tests.
 - 3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
 - 4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.

- 5) Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
 - a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
 - b) Perform efficiency testing with test fluids at maximum rated speed.
 - c) Perform priming time testing with test fluids at maximum rated speed.
2. Level 3 Vibration Test:
 - a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
 - b. Perform High Frequency Enveloping Analysis for gears and bearings.
 - 1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
 - 2) Report results in units of acceleration versus frequency in cycles per minute.
 - c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
 - d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
3. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plain view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Tests:

1. Level 4 Performance Test:
 - a. General:
 - 1) For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
 - 2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
 - 3) Confirm that equipment is properly assembled.
 - 4) Confirm the equipment moves or rotates in the proper direction.
 - 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
 - 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

- 7) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings, using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
 - 8) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
- b. Pumps:
- 1) Comply with general performance test requirements as specified in this Section.
 - 2) Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
 - 3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
 - 4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
 - 5) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
 - 6) Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
 - a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
 - b) Perform efficiency testing with test fluids at maximum rated speed.
 - c) Perform priming time testing with test fluids at maximum rated speed.
2. Level 4 Vibration Test: Same as Level 3 vibration test.
 3. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

END OF SECTION

SECTION 2

TECHNICAL SPECIFICATIONS

For the latest revisions to the Technical Specifications, please visit:

**Collier County Public Utilities
Engineering and Project Management Resources Webpage.**

**COLLIER COUNTY WATER-SEWER DISTRICT
UTILITIES STANDARDS MANUAL**

SECTION 2

TECHNICAL SPECIFICATIONS

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SECTION 011000
SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description of Work
- B. CONTRACTOR's Use of Site
- C. Work Sequence
- D. COUNTY Occupancy

1.2 DESCRIPTION OF WORK

- A. General: The Work to be done under this Contract is shown on the drawings and specified in Contract Documents.
- B. The Work includes:
 - 1. Furnishing of all labor, material, superintendence, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, services and other means of construction necessary or proper for performing and completing the Work.
 - 2. Sole responsibility for adequacy of plant and equipment.
 - 3. Maintaining the Work area and site in a clean and acceptable manner.
 - 4. Maintaining existing facilities in service at all times.
 - 5. Protection of finished and unfinished Work.
 - 6. Repair and restoration of Work or existing facilities damaged during construction.
 - 7. Furnishing as necessary proper equipment and machinery, of a sufficient capacity, to facilitate the Work and to handle all emergencies normally encountered in Work of this character.

8. Furnishing, installing, and protecting all necessary guides, track rails, bearing plates, anchor and attachment bolts, and all other appurtenances needed for the installation of the devices included in the equipment specified. Make anchor bolts of appropriate size, strength and material for the purpose intended. Furnish substantial templates and shop drawings for installation.
- C. Implied and Normally Required Work: It is the intent of these Specifications to provide the COUNTY with complete operable systems, subsystems and other items of Work. Any part or item of Work, which is reasonably implied or normally required to make each installation satisfactorily and completely operable, is deemed to be included in the Work and the Contract Amount. All miscellaneous appurtenances and other items of Work incidental to meeting the intent of these Specifications are included in the Work and the Contract Amount even though these appurtenances may not be specifically called for in these Specifications.
- D. Quality of Work: Regard the apparent silence of the Contract Documents as to any detail, or the apparent omission from them of a detailed description concerning any Work to be done and materials to be furnished as meaning that only the best general practice is to prevail and that only materials and workmanship of the best quality are to be used. Interpretation of these specifications will be made upon this basis.

1.3 CONTRACTOR'S USE OF SITE

- A. In addition to the requirements of the Supplemental Terms and Conditions, limit use of site and premises for work and storage to allow for the following:
 1. Coordination of the Work under this CONTRACT with the work of the other contractors where Work under this CONTRACT encroaches on the Work of other contractors.
 2. COUNTY occupancy and access to operate existing facilities.
 3. Coordination of site use with ENGINEER.
 4. Responsibility for protection and safekeeping of products under this CONTRACT.
 5. Providing additional off site storage at no additional cost to the COUNTY as needed.

1.4 WORK SEQUENCE

- A. Construct Work in stages to accommodate the COUNTY's use of premises during construction period and in accordance with the limitations on the sequence of construction specified. Coordinate construction schedules and operations with ENGINEER.

- B. Coordinate Work of all subcontractors.

1.5 COUNTY OCCUPANCY

- A. The COUNTY will occupy premises during entire period of construction in order to maintain normal operations. Cooperate with the COUNTY's Manager or designee in all construction operations to minimize conflict, and to facilitate COUNTY usage.
- B. Conduct operations with the least inconvenience to the general public.

1.6 PROTECTION OF EXISTING UTILITIES

- A. In case of damage to existing utilities caused by construction activities, contact the owner of the utility or appropriate COUNTY department (Water or Wastewater) immediately. Repair any damage to existing utilities caused by construction activities in coordination with or as directed by the owner of the utility.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

- A. Starting Work: Start Work within 10 days following the date stated in the Notice to Proceed and execute with such progress as may be required to prevent delay to other contractors or to the general completion of the project. Execute Work at such items and in or on such parts of the project, and with such forces, material and equipment, as to complete the Work in the time established by the Contract. At all times, schedule and direct the Work so that it provides an orderly progression to completion within the specified time for completion.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 014127

NPDES REQUIREMENTS

FOR CONSTRUCTION ACTIVITIES IMPACTING MORE THAN ONE ACRE

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section describes the required documentation to be prepared and signed by the CONTRACTOR before conducting construction operations, in accordance with the terms and conditions of the National Pollutant Discharge Elimination System (NPDES) Stormwater Permit, as required by Florida Administrative Code (F.A.C.) Chapter 62-621.
- B. The CONTRACTOR shall be responsible for implementation, maintenance and inspection of stormwater pollution prevention control measures in accordance with F.A.C. Chapter 62-621 including, but not limited to, erosion and sediment control, stormwater management plans, waste collection and disposal, off-site vehicle tracking, and other practices shown on the Drawings and/or specified elsewhere in this or other specifications. The stormwater pollution prevention control measures shall include protection of offsite public and private stormsewer facilities potentially impacted during construction. Stormwater facilities include streets, inlets, pipes, ditches, swales, canals, culverts, control structures, and detention/retention areas.
- C. The CONTRACTOR shall prepare and review implementation of the Stormwater Pollution Prevention Plan (SWPPP) in a meeting with the County Manager or designee prior to start of construction.

1.2 UNIT PRICES

- A. Unless indicated in the Unit Price Schedule as a pay item, no separate payment will be made for work performed under this Section. Include cost of work to be performed under this Section in pay items of which this work is a component.

1.3 REFERENCE DOCUMENTS

- A. ASTM D3786 – Standard Test Method for Hydraulic Bursting Strength for Knitted Goods and Nonwoven Fabrics
- B. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 NOTICE OF INTENT (NOI)

- A. Fill out, sign and date a Notice of Intent to Use Generic Permit for Stormwater Discharge from Large and Small Construction Activities, (FDEP Form 62-621.300(4)(b)). Submit the signed copy of the NOI to the County Manager or designee. The County Manager or designee will submit the completed form to the FDEP along with the required permit fee.

3.2 CERTIFICATION REQUIREMENTS

- A. On the attached OPERATOR'S INFORMATION form, fill out the name, address and telephone number for the CONTRACTOR, persons or firms responsible for maintenance and inspection of erosion and sediment control measures, and all Subcontractors.
- B. The CONTRACTOR and Subcontractors named in the Operator's Information form shall read, sign and date the attached CONTRACTOR'S/SUBCONTRACTOR'S CERTIFICATION form.
- C. The persons or firms responsible for maintenance and inspection of erosion and sediment control measures shall read, sign and date the attached EROSION CONTROL CONTRACTOR'S INSPECTION AND MAINTENANCE CERTIFICATION form.
- D. Submit all forms to the County Manager or designee before beginning construction.

3.3 RETENTION OF RECORDS

- A. Retain a copy of the SWPPP at the construction site and at the Contractor's office from the date that it became effective to the date of project completion.
- B. At project closeout, submit to the County Manager or designee all NPDES forms and certifications, as well as a copy of the SWPPP. Stormwater pollution prevention records will be retained by the County Manager or designee for a period of three (3) years from the date of project completion.

3.4 REQUIRED NOTICES

- A. The following notices shall be posted from the date that the SWPPP goes into effect until the date of final site stabilization:

1. A copy of the submitted NOI and a brief project description, as given in the SWPPP, shall be posted at the construction site and at the CONTRACTOR's office in a prominent place for public viewing.
2. Notice to drivers of equipment and vehicles, instructing them to stop, check and clean tires of debris and mud before driving onto traffic lanes. Post such notices at every stabilized construction exit area.
3. Post a notice of waste disposal procedures in an easily visible location on site.
4. Notice of hazardous material handling and emergency procedures shall be posted with the NOI on site. Keep copies of Material Safety Data Sheets at a location on site that is known to all personnel.
5. Keep a copy of each signed certification at the construction site and at the CONTRACTOR's office.

REQUIRED FORMS FOLLOW

OPERATOR'S INFORMATION

Owner's Name and Address:

Collier County Public Utilities Planning and Project
Management Department

3301 East Tamiami Trail
Naples, Florida 34112
(239) 252-4285

Contractors' Names and Addresses:

General Contractor:

Telephone: _____

Site Superintendent:

Telephone: _____

Erosion Control and:
Maintenance Inspection

Telephone: _____

Subcontractors' Names and Addresses:

Phone: _____

Phone: _____

CONTRACTOR'S / SUBCONTRACTOR'S CERTIFICATION

I certify under penalty of law that I understand the terms and conditions of Florida's National Pollutant Discharge Elimination System (NPDES) Construction General Permit that authorizes storm water discharges associated with activity from the construction site identified as part of this certification, and that I have received a copy of the SWPPP.

Signature: _____

Name: (printed or typed) _____

Title: _____

Company: _____

Address: _____

Signature: _____

Name: (printed or typed) _____

Title: _____

Company: _____

Address: _____

Signature: _____

Name: (printed or typed) _____

Title: _____

Company: _____

Address: _____

**EROSION CONTROL CONTRACTOR'S
INSPECTION AND MAINTENANCE CERTIFICATION**

I certify under penalty of law that I understand the terms and conditions of Florida's National Pollutant Discharge Elimination System (NPDES) Construction General Permit that authorizes storm water discharges associated with activity from the construction site identified as part of this certification, and that I have received a copy of the SWPPP.

Signature: _____

Name: (printed or typed) _____

Title: _____

Company: _____

Address: _____

Date: _____

STORM WATER POLLUTION PREVENTION PLAN INSPECTION AND MAINTENANCE REPORT

Project: _____

Contractor: _____

Inspector: _____

Date: _____

CONTROLS	LOCATION	SEDIMENT HEIGHT	PROBLEM DESCRIPTION	MAINTENANCE REQUIRED	REPAIRED BY / DATE

END OF SECTION

SECTION 014200

REFERENCES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reference Abbreviations
- B. Abbreviations
- C. Reference Standards
- D. Definitions

1.2 RELATED SECTIONS

- A. Information provided in this section is used where applicable in individual Specification Sections.

1.3 REFERENCE ABBREVIATIONS

- A. Reference to a technical society, trade association or standards setting organization, may be made in the Specifications by abbreviations in accordance with the following list:

AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ACI	American Concrete Institute
ADC	Air Diffusion Council
AFBMA	Anti-friction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	Association of Home Appliance Manufacturers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
APA	American Plywood Association
ARI	American Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers

ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders' Hardware Manufacturers Association
BIA	Brick Institute of American
CABO	Council of American Building Officials
CAGI	Compressed Air and Gas Institute
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRD	U.S. Corps of Engineers Specifications
CRSI	Concrete Reinforcing Steel Institute
CTI	Cooling Tower Institute
DHI	Door and Hardware Institute
DOH	Department of Health
DOT	Department of Transportation
Fed. Spec.	Federal Specifications
FGMA	Flat Glass Marketing Association
FM	Factory Mutual
HMI	Hoist Manufacturing Institute
HPMA	See HPVA
HPVA	Hardwood Plywood Veneer Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IFI	Industrial Fasteners Institute
MIL	Military Specifications
MSS	Manufacturer's Standardization Society
NAAMM	National Association of Architectural Metal Manufacturers
NACM	National Association of Chain Manufacturers
NBS	National Bureau of Standards, See NIST
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NFPA	National Fluid Power Association
NIST	National Institute of Standards and Technology
NLMA	National Lumber Manufacturers Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Act
PCI	Prestressed Concrete Institute
PDI	Plumbing and Drainage Institute
SAE	Society of Automotive Engineers
SCPRF	Structural Clay Products Research Foundation
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association

SPI	Society of the Plastics Industry
SSPC	Steel Structures Painting Council
STI	Steel Tank Institute
TCA	Tile Council of American
TIMA	Thermal Insulation Manufacturers' Association
UL	Underwriters' Laboratories, Inc.
USBR	U. S. Bureau of Reclamation
USBS	U. S. Bureau of Standards, See NIST

1.4 ABBREVIATIONS

- A. Abbreviations which may be used in individual Specification Sections are as follows:

alternating current.....ac	cubic foot (feet) cu ft
American wire gauge AWG	cubic inch(es) cu in
ampere(s) amp	cubic yard(s) cu yd
ampere-hour(s) AH	
annual ann	decibels..... dB
Ampere Interrupting	decibels (A scale) dBa
Capacity AIC	degree(s) deg
atmosphere(s).....atm	dewpoint temperature dpt
average avg	diameter dia
	direct current..... dc
biochemical oxygen demand BOD	dissolved oxygen DO
Board Foot FBM	dissolved solids DS
brake horsepower bhp	dry-bulb temperature dbt
Brinell Hardness BH	
British thermal unit(s)..... Btu	efficiency..... eff
	elevation el
calorie(s) cal	entering water temperature ewt
carbonaceous biochemical	entering air temperature eat
oxygen demand CBOD	equivalent direct radiation edr
Celsius (centigrade)..... C	
Center to Center C to C	face area fa
centimeter(s) cm	face to face f to f
chemical oxygen demand COD	Fahrenheit F
coefficient, valve flow C _v	feet per day fpd
condensate return CR	feet per hour fph
cubic cu	feet per minute fpm
cubic centimeter(s) cc	feet per second fps
cubic feet per day cfd	foot (feet) ft
cubic feet per hour cfh	foot-candle fc
cubic feet per minute cfm	foot-pound ft-lb
cubic feet per minute,	foot-pounds per minute ft-lb/min
standard conditions..... scfm	foot-pounds per second ft-lb/sec
cubic feet per second..... cfs	formazin turbidity unit(s) FTU

frequency freq
 fuel oil FO
 fuel oil supply FOS
 fuel oil return FOR

 gallon(s) gal
 gallons per day gpd
 gallons per day per
 cubic foot gpd/cu ft
 gallons per day per
 square foot gpd/sq ft
 gallons per hour gph
 gallons per minute gpm
 gallons per second gps
 gas chromatography and
 mass spectrometry GC-MS
 gauge ga
 grain(s) gr
 gram(s) g
 grams per cubic centimeter gm/cc
 Heat Transfer Coefficient U
 height hgt
 Hertz Hz
 horsepower hp
 horsepower-hour hp-hr
 hour(s) hr
 humidity, relative rh
 hydrogen ion concentration pH

 inch(es) in
 inches per second ips
 inside diameter ID

 Jackson turbidity unit(s) JTU

 kelvin K
 kiloamperes kA
 kilogram(s) kg
 kilometer(s) km
 kilovar (kilovolt-amperes
 reactive) kvar
 kilovolt(s) kV
 kilovolt-ampere(s) kVA
 kilowatt(s) kW
 kilowatt-hour(s) kWh

 linear foot (feet) lin ft
 liter(s) L

megavolt-ampere(s) MVA
 meter(s) m
 micrograms per liter ug/L
 miles per hour mph
 milliamperes mA
 milligram(s) mg
 milligrams per liter mg/L
 milliliter(s) mL
 millimeter(s) mm
 million gallons MG
 million gallons per day mgd
 millisecond(s) ms
 millivolt(s) mV
 minute(s) min
 mixed liquor suspended
 solids MLSS
 nephelometric turbidity
 unit NTU
 net positive suction head NPSH
 noise criteria nc
 noise reduction coefficient NRC
 number no

 ounce(s) oz
 outside air oa
 outside diameter OD

 parts per billion ppb
 parts per million ppm
 percent pct
 phase (electrical) ph
 pound(s) lb
 pounds per cubic foot pcf
 pounds per cubic foot
 per hour pcf/hr
 pounds per day lbs/day
 pounds per day per
 cubic foot lbs/day/cu ft
 pounds per day per
 square foot lbs/day/sq ft
 pounds per square foot psf
 pounds per square foot
 per hour psf/hr
 pounds per square inch psi

 pounds per square inch
 absolute psia

pounds per square inch
gauge psig
power factor PF
pressure drop or
difference dp
pressure, dynamic
(velocity) vp
pressure, vapor vap pr

quart(s) qt

Rankine R
relative humidity rh
resistance res
return air ra
revolution(s) rev
revolutions per minute rpm
revolutions per second rps
root mean squared rms

safety factor sf
second(s) sec
shading coefficient SC
sludge density index SDI

Sound Transmission
Coefficient STC
specific gravity sp gr
specific volume Sp Vol
sp ht at constant pressure Cp
square sq
square centimeter(s) sq cm
square foot (feet) sq ft
square inch (es) sq in
square meter(s) sq m
square yard(s) sq yd
standard std
static pressure st pr
supply air sa
suspended solids SS

temperature temp
temperature difference TD
temperature entering TE
temperature leaving TL
thousand Btu per hour Mbh
thousand circular mils kcmil
thousand cubic feet Mcf
threshold limit value TLV
tons of refrigeration tons
torque TRQ
total dissolved solids TDS
total dynamic head TDH
total kjeldahl nitrogen TKN
total oxygen demand TOD
total pressure TP
total solids TS
total suspended solids TSS
total volatile solids TVS
vacuum vac
viscosity visc
volatile organic chemical VOC
volatile solids VS
volatile suspended solids VSS
volt(s) V
volts-ampere(s) VA
volume vol
watt(s) W
watthour(s) Wh
watt-hour demand WHD
watt-hour demand meter WHDM
week(s) wk
weight wt
wet-bulb WB
wet bulb temperature WBT

yard(s) yd
year(s) yr

1.5 REFERENCE PUBLICATIONS

The following publications are incorporated into this Manual and are made a part of this Manual as is set out verbatim in this Manual. Violations of any provision of every such publication, as updated from time-to-time by Resolution(s) of the Board of County

Commissioners, shall be a violation of the Collier County Utilities Standards and Procedures Ordinance, as then amended.

- A. Water Environment Federation, Manual of Practice No. 8, Wastewater Treatment Plant Design, W.E.F., 601 Wythe Street, Alexandria, VA, 22314-1994.
- B. Water Environment Federation, Manual of Practice No. 9, Design and Construction of Sanitary and Storm Sewers, W.E.F., 601 Wythe Street, Alexandria, VA, 22314-1994.
- C. Great Lakes/Upper Mississippi River Board of State Sanitary Engineers. Recommended Standards for Sewage Works, Health Education Service, Inc., P.O. Box 7283, Albany, New York, 12224.
- D. Great Lakes/Upper Mississippi River Board of State Sanitary Engineers. Recommended Standards for Water Works, Health Education Service, Inc., P.O. Box 7283, Albany, New York, 12224.
- E. Rules of the Florida Department of Environmental Protection for Water, Wastewater, and Reclaimed Water Systems, latest revisions of F.A.C. Chapters 62-550, 62-555, 62-600, 62-604, 62-610, 64E-6, and 64E-8, 3900 Commonwealth Boulevard M.S. 49, Tallahassee, Florida, 32399.
- F. American Water Works Association, Inc., Water Treatment Plant Design, 6666 West Quincy Avenue, Denver, Colorado, 80235.
- G. American Water Works Association, Inc., Water Treatment Plant Design, AWWA Standards and Applicable Manuals, 6666 West Quincy Avenue, Denver, Colorado, 80235.
- H. Ductile Iron Pipe Research Association, Handbook, Ductile Iron Pipe/Cast Iron Pipe, Ductile Iron Pipe Research Association, 245 Riverchase Parkway East, Birmingham, Alabama, 35244.
- I. Uni-Bell Plastic Pipe Association, Handbook of PVC Pipe, Uni-Bell Plastic Pipe Association, 2655 Villa Creek Drive, Suite 164, Dallas, Texas, 75234.
- J. American National Standards Institute, latest revisions of applicable standards, 1819 L Street NW, Suite 600, Washington, D.C., 20036.
- K. American Society for Testing and Materials, latest revisions of applicable standards, ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania, 19428-2959.
- L. National Water Research Institute, Treatment Technologies for Removal of MTBE. NWRI, 10500 Ellis Ave., P.O. Box 20865, Fountain Valley, CA, 92728.

- M. National Water Research Institute, Valuing Ground Water: Economic Concepts/Approaches. NWRI, 10500 Ellis Ave., P.O. Box 20865, Fountain Valley, CA, 92728.7.3.14.
- N. U.S. Environmental Protection Agency, Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability, Supplement to the Federal Guidelines for Design, Operation, and Maintenance of Wastewater Treatment Facilities, Technical Bulletin EPA-430-99-74-001, U.S. EPA, Office of Water Program Operations.
- O. Florida Department of Transportation, Standard Specifications for Road and Bridge Construction, Maps & Publications Sales, Mail Station 12, 605 Suwannee Street, Tallahassee, Florida 32399-0450.
- P. Plastics Pipe Institute, Handbook of Polyethylene Pipe, 1825 Connecticut Ave., NW, Suite 680, Washington, DC 20009.
- Q. National Fire Protection Association, 1995 Edition of NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances, 1 Batterymarch Park, Quincy, MA 02169.
- R. Collier County Water-Sewer District Utilities Standards Manual.
- S. National Electrical Code, latest revisions of applicable requirements.
- T. Metcalf and Eddy, Wastewater Engineering Treatment and Reuse, 4th Edition, McGraw-Hill, 2002.
- U. Water Environment Federation, Manual of Practice No. 11, Operation of Municipal Wastewater Treatment Plants, 601 Wythe Street, Alexandria, VA 22314-1994.

1.6 REFERENCE STANDARDS

- A. Latest Edition: Construe references to furnishing materials or testing, which conform to the standards of a particular technical society, organization, or body, to mean the latest standard, code, or specification of that body, adopted and published as of the date of bidding this Contract. Standards referred to herein are made a part of these Specifications to the extent that is indicated or intended.
- B. Precedence: The duties and responsibilities of the COUNTY, CONTRACTOR or ENGINEER, or any of their consultants, agents or employees are set forth in the Contract Documents, and are not changed or altered by any provision of any referenced standard specifications, manuals or code, whether such standard manual or code is or is not specifically incorporated by reference in the Contract Documents. Any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority, to undertake responsibility contrary to the powers of the ENGINEER as set forth in the Contract Documents cannot be assigned to the ENGINEER or any of the ENGINEER's consultants, agents or employees.

1.7 DEFINITIONS

A. In these Contract Documents the words furnish, install and provide are defined as follows:

1. Furnish (Materials): to supply and deliver to the project ready for installation and in operable condition.
2. Install (services or labor): to place in final position, complete, anchored, connected in operable condition.
3. Provide: to furnish and install complete. Includes the supply of specified services. When neither furnish, install or provide is stated, provided is implied.
4. COUNTY: Collier County Board of Commissioners, County Government Center, 3301 East Tamiami Trail, Naples, Florida 34112, or authorized staff or representatives.
5. ENGINEER: The terms Design Professional, Design Engineer, and Engineer are interchangeably used throughout the Contract Documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 014500
QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Submittals
- B. Inspection Services
- C. Inspection of Materials
- D. Quality Control
- E. Costs of Inspection
- F. Acceptance Tests
- G. Failure to Comply with Contract

1.2 SUBMITTALS

- A. General: Provide all submittals, including the following, as specified in the individual material sections.
- B. Certificate Submittals: Furnish the ENGINEER authoritative evidence in the form of Certificates of Manufacture that the materials and equipment to be used in the Work have been manufactured and tested in conformity with the Contract Documents. Include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

1.3 INSPECTION SERVICES

- A. COUNTY's Access: At all times during the progress of the Work, and until the date of final completion, afford the County Manager or designee and ENGINEER every reasonable, safe, and proper facility for inspecting the Work at the site. The observation and inspection of any work will not relieve the CONTRACTOR of any obligations to perform proper and satisfactory work as specified. Replace work rejected due to faulty design, inferior, or defective materials, poor workmanship, improper installation, excessive wear, or nonconformity with the requirements of the Contract Documents, with satisfactory work at no additional cost to the COUNTY. Replace as directed, finished or unfinished work found not

to be in strict accordance with the Contract, even though such work may have been previously approved and payment made therefor.

- B. Rejection: The County's Manager or designee has the right to reject materials and workmanship which are defective or require correction. Promptly remove rejected work and materials from the site.
- C. Inferior Work Discoveries: Failure or neglect on the part of the County Manager or designee to condemn or reject bad or inferior work or materials does not imply an acceptance of such work or materials. Neither is it to be construed as barring the County Manager or designee at any subsequent time from recovering damages or a sum of money needed to build anew all portions of the Work in which inferior work or improper materials were used.
- D. Removal for Examination: Should it be considered necessary or advisable by the County Manager or designee, at any time before final acceptance of the Work, to make examinations of portions of the Work already completed, by removing or tearing out such portions, promptly furnish all necessary facilities, labor, and material, to make such an examination. If such Work is found to be defective in any respect, defray all expenses of such examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the Contract, the cost of examination and restoration of the Work will be considered a change in the Work to be paid for in accordance with applicable provisions of the Contract.
- E. Operation Responsibility: Assume full responsibility for the proper operation of equipment during tests and instruction periods. Make no claim, other than provided in the Contract Documents, for damage that may occur to equipment prior to the time when the County Manager or designee accepts the Work.
- F. Rejection Prior to Warranty Expiration: If at anytime prior to the expiration of any applicable warranties or guarantees, defective equipment is rejected by the County Manager or designee, repay to the COUNTY all sums of money received for the rejected equipment on progress certificates or otherwise on account of the Contract lump sum prices, and upon the receipt of the sum of money, County Manager or designee will execute and deliver a bill of sale of all its rights, title, and interest in and to the rejected equipment. Do not remove the equipment from the premises of the COUNTY until the County Manager or designee obtains from other sources, equipment to take the place of that rejected. The County Manager or designee hereby agrees to obtain other equipment within a reasonable time and the CONTRACTOR agrees that the COUNTY may use the equipment furnished by the CONTRACTOR without rental or other charge until the other new equipment is obtained.

1.4 INSPECTION OF MATERIALS

- A. Premanufacture Notification: Give notice in writing to the ENGINEER sufficiently in advance of the commencement of manufacture or preparation of materials

especially manufactured or prepared for use in or as part of the permanent construction. When required, notice to include a request for inspection, the date of commencement, and the expected date of completion of the manufacture or preparation of materials. Upon receipt of such notice, ENGINEER will arrange to have a representative present at such times during the manufacture or testing as may be necessary to inspect the materials, or will notify CONTRACTOR that the inspection will be made at a point other than the point of manufacture or testing, or that the inspection will be waived. Comply with these provisions before shipping any materials. Such inspection will not constitute a release from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

- B. Testing Standards: Conduct tests of electrical and mechanical equipment and appliances in accordance with recognized, applicable test codes.

1.5 QUALITY CONTROL

A. Testing

1. Field and Laboratory

- a. Provide personnel to assist the ENGINEER in performing the following periodic observation and associated services.
 - (1) Soils: Observe and test excavations, placement and compaction of soils. Determine suitability of excavated material. Observe subgrade soils and foundations.
 - (2) Concrete: Observe forms and reinforcement; observe concrete placement; witness air entrainment tests, facilitate concrete cylinder preparation and assist with other tests performed by ENGINEER.
 - (3) Masonry: Sample and test mortar, bricks, blocks and grout; inspect brick and block samples and sample panels; inspect placement of reinforcement and grouting.
 - (4) Structural Steel: Verify that all welders are certified; visually inspect all structural steel welds; mechanically test high-tensile bolted connections.
- b. When specified in the Contract Documents, provide an independent laboratory testing facility to perform required testing. Qualify the laboratory as having performed previous satisfactory work. Prior to use, submit to the ENGINEER for approval.
- c. Cooperate with the ENGINEER and laboratory testing representatives. Provide at least 24 hours notice prior to when specified testing is

required. Provide labor and materials, and necessary facilities at the site as required by the ENGINEER and the testing laboratory.

- d. When an independent electrical testing agency is specified in the Contract Documents, provide a member of the National Electrical Testing Association to perform inspections and tests.
2. Equipment: Coordinate and demonstrate test procedures as specified in the Contract Documents and as required during the formal tests.
 3. Pipeline and Other Testing: Conform to test procedures and requirements specified in the appropriate Specification Section.
 4. Testing of Gravity Sanitary Sewer Lines
 - a. Watertight Construction: It is imperative that all sewers and force mains, manholes, and service connections be built watertight and that the CONTRACTOR adhere rigidly to the specifications for material and workmanship. Since all of the water and sewage in the lines will be treated at the treatment plant, special care and attention must be given to securing watertight construction. After completion, the sewers or sections thereof will be tested and gauged. If infiltration or exfiltration is above the limits specified, the sewer construction work will be rejected.
 - b. Cleaning: Exercise care during construction of the manhole to see that materials do not enter the sewer line. Keep the invert and shelf of the manhole clean of all mortar, broken brick, sand, or any other materials falling into the manhole. Immediately remove such material. Maintain this condition until final acceptance of the work. Prior to testing of gravity sanitary sewer lines, clean the lines using appropriate tools.
 - c. Gravity Sewers - Visual Inspections: On completion of each block or section of sewer, or at such other times as the County Manager or designee may direct, the block or section of sewer is to be cleaned, tested and inspected. Each section of the sewer is to show, on examination from either end, a full circle of light between manholes. Each manhole, or other appurtenance to the system, shall be of the specified size and form, be watertight, neatly and substantially constructed, with the rim set permanently to design position and grade. All repairs shown necessary by the inspection are to be made; broken or cracked pipe replaced, all deposits removed and the sewers left true to line and grade, entirely clean and ready for use.

- d. Infiltration Limits: Provide the equipment necessary to check the lines for infiltration or exfiltration as directed by the County Manager or designee, before they are put in service. Infiltration in excess of fifty (50) gallons per day inch-mile of sewer will result in having the CONTRACTOR go over the lines, ascertain where the leakage exists, and repair the lines to the extent necessary to bring the infiltration down within acceptable limits. Observable inflow is not permitted.
- e. Exfiltration Limits: The length of sewer subject to an exfiltration test shall be the distance between two (2) adjacent manholes. Close the inlets of the upstream and downstream manholes with watertight plugs and the test section filled with water until the elevation of the water in the upstream manhole is two (2) feet above the crown of the pipe in the line being tested, or two (2) feet above the existing groundwater in the trench, whichever is higher. A standpipe may be used instead of the upstream manhole for providing the pressure head when approved by the County Manager or designee. Measure exfiltration by determining the amount of water required to maintain the initial water elevation for one (1) hour period from the start of the test. The maximum allowable leakage, including manholes, shall be 50 gallon per inch for diameter per mile of pipe per day.
- f. Air Testing: Air testing shall be required if, in the opinion of the County Manager or designee, conditions are such that infiltration measurements may be inconclusive. Conduct the test in the presence of the County Manager or designee and conform to the following requirements:
 - (a) Test pressure shall be 3.5 psi increased by the groundwater pressure above the top of the sewer.
 - (b) Pressure loss from shall not exceed 0.5 psi during the required testing time.
 - (c) Testing time in minutes shall be calculated as $0.625 \times$ nominal pipe size (inches).
- g. Deformation Test
 - (a) Deformation tests shall be performed on all gravity sewer lines. The test shall be conducted after the final backfill has been in place at least 30 days to permit stabilization of the soil-pipe system.
 - (b) No pipe shall exceed a deformation of five percent (5%). If deformation exceeds 5%, mechanical methods to correct deformation may be used. If mechanical methods are unsuccessful, the pipe shall be excavated. Replacement

or correction shall be accomplished in accordance with requirements in the approved specifications.

- (c) The rigid ball or mandrel used for the deflection test shall have a diameter not less than 95 percent of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM Specification, including the appendix, to which the pipe is manufactured. The test shall be performed without mechanical pulling devices.

B. Reports

1. Certified Test Reports: Where transcripts or certified test reports are required by the Contract Documents, meet the following requirements:
 - a. Before delivery of materials or equipment submit and obtain approval of the ENGINEER for all required transcripts, certified test reports, certified copies of the reports of all tests required in referenced specifications or specified in the Contract Documents. Perform all testing in an approved independent laboratory or the manufacturer's laboratory. Submit for approval reports of shop equipment tests within thirty days of testing. Transcripts or test reports are to be accompanied by a notarized certificate in the form of a letter from the manufacturer or supplier certifying that tested material or equipment meets the specified requirements and the same type, quality, manufacture and make as specified. The certificate shall be signed by an officer of the manufacturer or the manufacturer's plant manager.
2. Certificate of Compliance: At the option of the ENGINEER, submit for approval a notarized Certificate of Compliance. The Certificates may be in the form of a letter stating the following:
 - a. Manufacturer has performed all required tests
 - b. Materials to be supplied meet all test requirements
 - c. Tests were performed not more than one year prior to submittal of the certificate
 - d. Materials and equipment subjected to the tests are of the same quality, manufacture and make as those specified
 - e. Identification of the materials

1.6 COSTS OF INSPECTION

- A. COUNTY's Obligation: Initial inspection and testing of materials furnished under this Contract will be performed by the County Manager or designee, or inspection bureaus without cost to the CONTRACTOR, unless otherwise expressly specified. If subsequent testing is necessary due to failure of the initial tests or because of rejection for noncompliance, reimburse the COUNTY for expenditures incurred in making such tests.
- B. CONTRACTOR's Obligation: Include in the Contract Price, the cost of all shop and field tests of equipment and other tests specifically called for in the Contract Documents, except those tests described above under "COUNTY's Obligation". The County Manager or designee may perform tests on any material or equipment furnished under this Contract at any time during the Contract. If tests performed by the County Manager or designee result in failure or rejection for noncompliance, reimburse the COUNTY for expenditures incurred in making such tests. Tests performed by the County Manager or designee shall prevail in determining compliance with Contract requirements.
- C. Reimbursements to the COUNTY:
 - 1. Materials and equipment submitted by the CONTRACTOR as the equivalent to those specifically named in the Contract may be tested by the County Manager or designee for compliance. Reimburse the COUNTY for expenditures incurred in making such tests on materials and equipment that are rejected for noncompliance.
 - 2. Reimburse the COUNTY for all costs associated with Witness Tests that exceed 5 Calendar Days per kind of equipment.

1.7 ACCEPTANCE TESTS

- A. Preliminary Field Tests: As soon as conditions permit, furnish all labor and materials and services to perform preliminary field tests of all equipment provided under this Contract. If the preliminary field tests disclose that any equipment furnished and installed under this Contract does not meet the requirements of the Contract Documents, make all changes, adjustments and replacements required prior to the acceptance tests.
- B. Final Field Tests: Upon completion of the Work and prior to final payment, subject all equipment, piping and appliances installed under this Contract to specified acceptance tests to demonstrate compliance with the Contract Documents.
 - 1. Furnish all labor, fuel, energy, water and other materials, equipment, instruments and services necessary for all acceptance tests.

2. Conduct field tests in the presence of the ENGINEER. Perform the field tests to demonstrate that under all conditions of operation each equipment item:
 - a. Has not been damaged by transportation or installation
 - b. Has been properly installed
 - c. Has been properly lubricated
 - d. Has no electrical or mechanical defects
 - e. Is in proper alignment
 - f. Has been properly connected
 - g. Is free of overheating of any parts
 - h. Is free of all objectionable vibration
 - i. Is free of overloading of any parts
 - j. Operates as intended
 3. Operate work or portions of work for a minimum of 100 hours or 14 days continuous service, whichever comes first. For those items of equipment that would normally operate on wastewater or sludge, plant effluent may be used if available when authorized by ENGINEER. If water cannot properly exercise equipment, conduct 100-hour test after plant startup. Conduct test on those systems that require load produced by weather (heating or cooling) exercise only when weather will produce proper load.
- C. Failure of Tests: If the acceptance tests reveal defects in material or equipment, or if the material or equipment in any way fails to comply with the requirements of the Contract Documents, then promptly correct such deficiencies. Failure or refusal to correct the deficiencies, or if the improved materials or equipment, when tested again, fail to meet the guarantees or specified requirements, the County Manager or designee, notwithstanding its partial payment for work and materials or equipment, may reject said materials or equipment and may order the CONTRACTOR to remove the defective work from the site at no addition to the Contract Price, and replace it with material or equipment which meets the Contract Documents.

1.8 FAILURE TO COMPLY WITH CONTRACT

- A. Unacceptable Materials: If it is ascertained by testing or inspection that the material or equipment does not comply with the Contract, do not deliver said material or equipment, or if delivered remove it promptly from the site or from the

Work and replace it with acceptable material without additional cost to the COUNTY. Fulfill all obligations under the terms and conditions of the Contract even though the County Manager or designee fail to ascertain noncompliance or notify the CONTRACTOR of noncompliance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 015000

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General Requirements
- B. Related Sections
- C. Temporary Utilities
- D. Temporary Construction
- E. Barricades and Enclosures
- F. Fences
- G. Security
- H. Temporary Controls
- I. Traffic Regulation
- J. Field Offices and Sheds

1.2 RELATED SECTIONS

- A. Section 011000 - Summary of Work
- B. Section 015526 – Traffic Regulations and Public Safety
- C. Section 020500 – Connection to Existing Systems
- D. Section 312319 – Groundwater Control for Open Cut Excavation
- E. Section 320117 - Pavement Repair and Restoration
- F. Section 330518 –Laying and Jointing Buried Pipelines

1.3 GENERAL REQUIREMENTS

- A. Plant and Facilities: Furnish, install, maintain and remove all false work, scaffolding, ladders, hoistways, braces, pumping plants, shields, trestles,

roadways, sheeting, centering forms, barricades, drains, flumes, and the like, any of which may be needed in the construction of any part of the Work and which are not herein described or specified in detail. Accept responsibility for the safety and efficiency of such works and for any damage that may result from their failure or from their improper construction, maintenance or operation.

- B. First Aid: Maintain a readily accessible, completely equipped first aid kit at each location where work is in progress.
- C. Safety Responsibility: Accept sole responsibility for safety and security at the site. Indemnify and hold harmless the COUNTY and the County's Manager or designee, including the ENGINEER, for any safety violation, or noncompliance with governing bodies and their regulations, and for accidents, deaths, injuries, or damage at the site during occupancy or partial occupancy of the site by CONTRACTOR's forces while performing any part of the Work.
- D. Hazard Communication: Furnish two copies of the CONTRACTOR's Hazard Communication Program required under OSHA regulations before beginning on site activities. Furnish two copies of amendments to Hazard Communications Program as they are prepared.

1.4 TEMPORARY UTILITIES

- A. Water: Provide all necessary and required water without additional cost, unless otherwise specified. If necessary, provide and lay water lines to the place of use; secure all necessary permits; pay for all taps to water mains and hydrants and for all water used at the established rates.
- B. Light and Power: Provide without additional cost to the COUNTY temporary lighting and power facilities required for the proper construction and inspection of the Work. If, in the ENGINEER's opinion, these facilities are inadequate, do NOT proceed with any portion of the Work affected thereby. Maintain temporary lighting and power until the Work is accepted.
- C. Heat: Provide temporary heat, whenever required, for work being performed during cold weather to prevent freezing of concrete, water pipes, and other damage to the Work or existing facilities.
- D. Sanitary Facilities: Provide sufficient sanitary facilities for construction personnel. Prohibit and prevent nuisances on the site of the Work or on adjoining property. Discharge any employee who violates this rule. Abide by all environmental regulations or laws applicable to the Work.

1.5 TEMPORARY CONSTRUCTION

- A. Bridges: Design and place suitable temporary bridges where necessary for the maintenance of vehicular and pedestrian traffic. Assume responsibility for the

sufficiency and safety of all such temporary work or bridges and for any damage that may result from their failure or their improper construction, maintenance, or operation. Indemnify and save harmless the COUNTY and the COUNTY's representatives from all claims, suits or actions, and damages or costs of every description arising by reason of failure to comply with the above provisions.

1.6 BARRICADES, LIGHTS AND ENCLOSURES

- A. Protection of Workmen and Public: Effect and maintain at all times during the prosecution of the Work, barriers, lights and enclosures necessary for the protection of workmen and the public. Perform all work within the County right-of-way in strict accordance with the COUNTY Maintenance of Traffic Policy and other applicable statutory requirements.
- B. Provide suitable barricades, lights, signs and watchmen at excavation sites and all other places where the Work causes obstructions to normal traffic or constitutes in any way a hazard to the public.

1.7 FENCES

- A. Existing Fences: Obtain written permission from property owner(s) prior to relocating or dismantling fences that interfere with construction operations. Reach agreements with the fence owner as to the period the fence may be left relocated or dismantled. Install adequate gates where fencing must be maintained. Keep gates closed and locked at all times when not in use.
- B. Restoration: Restore all fences to their original or better condition and to their original location on completion of the Work.

1.8 SECURITY

- A. Preservation of Property:
 - 1. Preserve from damage, all property along the line of the Work, in the vicinity of or in any way affected by the Work, the removal or destruction of which is not called for by the Drawings. Preserve from damage, public utilities, trees, lawn areas, building monuments, fences, pipe and underground structures, and public streets. Note: Normal wear and tear of streets resulting from legitimate use by the CONTRACTOR are not considered as damage. Whenever damages occur to such property, immediately restore to its original condition. Costs for such repairs are incidental to the Contract.
 - 2. In case of failure on the part of the CONTRACTOR to restore property or make good on damage or injury, the County Manager or designee may, upon 24 hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from any moneys due or which may become due the

CONTRACTOR under this Contract. If removal, repair or replacement of public or private property is made necessary by alteration of grade or alignment authorized by the County Manager or designee and not contemplated by the Contract Documents, the CONTRACTOR will be compensated, in accordance with the General Conditions, provided that such property has not been damaged through fault of the CONTRACTOR or the CONTRACTOR's employees.

B. Public Utility Installations and Structures:

1. Public utility installations and structures include all poles, tracks, pipes, wires, conduits, vaults, valves, hydrants, manholes, and other appurtenances and facilities, whether owned or controlled by public bodies or privately owned individuals, firms or corporations, used to serve the public with transportation, gas, electricity, telephone, storm and sanitary sewers, water, or other public or private utility services. Facilities appurtenant to public or private property that may be affected by the Work are deemed included hereunder.
2. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. Existing public utility installations and structures are indicated on the Drawings only to the extent such information was made available to, or found by, the ENGINEER in preparing the Drawings. These data are not guaranteed for completeness or accuracy, and the CONTRACTOR is responsible for making necessary investigations to become fully informed as to the character, condition, and extent of all public utility installations and structures that may be encountered and that may affect the construction operations.
3. Before starting construction, identify and mark all existing valves and maintain access to the valves at all times during construction.
4. Contact utility locating service sufficiently in advance of the start of construction to avoid damage to the utilities and delays to the completion date.
5. If existing utilities are damaged during the Work, immediately notify the owner of the affected utility. In coordination with or as directed by the owner, remove, replace, relocate, repair, rebuild, and secure any public utility installations and structures damaged as a direct or indirect result of the Work under this Contract. Costs for such work are incidental to the Contract. Be responsible and liable for any consequential damages done to or suffered by any public utility installations or structures. Assume and accept responsibility for any injury, damage, or loss that may result from or be consequent to interference with, or interruption or discontinuance of, any public utility service.

6. At all times in the performance of Work, employ proven methods and exercise reasonable care and skill to avoid unnecessary delay, injury, damage, or destruction to public utility installations and structures. Avoid unnecessary interference with, or interruption of, public utility services. Cooperate fully with the owners thereof to that end.
 7. Provide notice to the County Manager or designee of any proposed connections to existing utilities, interruptions of service or shutdowns in accordance with Section 020500. Give written notice to the owners of all public utility installations and structures affected by proposed construction operations sufficiently in advance of breaking ground in any area or on any unit of the Work, to obtain their permission before disrupting the lines and to allow them to take measures necessary to protect their interests. Advise the Transportation Operations Department, Fire and Rescue Services of any excavation in public streets or the temporary shut-off of any water main. Provide at least 48 hours notice to all affected property owners whenever service connections are taken out of service.
- C. Work on Private Property: Work on this project will require operations on private property, rights of way or easements. The County Manager or designee has secured the appropriate easements or rights of entry from the affected property owners. Comply with all easement or rights of entry provisions. Conduct operations along rights-of-way and easements through private property to avoid damage to the property and to minimize interference with its ordinary use. Upon completion of the Work through such property, restore the surface and all fences or other structures disturbed by the construction as nearly as possible to the preconstruction conditions. Do not remove any material from private property without the consent of the property owner or responsible party in charge of such property. Hold the COUNTY harmless from any claim or damage arising out of or in connection with the performance of work across and through private property.
- D. Miscellaneous Structures: Assume and accept responsibility for all injuries or damage to culverts, building foundations and walls, retaining walls, or other structures of any kind met with during the prosecution of the Work. Assume and accept liability for damages to public or private property resulting therefrom. Adequately protect against freezing all pipes carrying liquid.
- E. Protection of Trees and Lawn Areas:
1. Protect with boxes, trees and shrubs, except those ordered to be removed. Do not place excavated material so as to cause injury to such trees or shrubs. Replace trees or shrubs destroyed by accident or negligence of the CONTRACTOR or CONTRACTOR's employees with new stock of similar size and age, at the proper season, at no additional cost to the COUNTY. If required by Contract Documents, provide preconstruction audio-video recording of project in accordance with the Technical Specifications.

2. Leave lawn areas in as good condition as before the start of the Work. Restore areas where sod has been removed by seeding or sodding.

1.9 TEMPORARY CONTROLS

A. During Construction:

1. Keep the site of the Work and adjacent premises free from construction materials, debris, and rubbish. Remove this material from any portion of the site if such material, debris, or rubbish constitutes a nuisance or is objectionable.
2. Remove from the site all surplus materials and temporary structures when they are no longer needed.
3. Neatly stack construction materials such as concrete forms and scaffolding when not in use. Store pipe to be incorporated into the Work in accordance with AWWA standards. Promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.
4. Properly store volatile wastes in covered metal containers and remove from the site daily.
5. Do not bury or burn on the site or dispose of into storm drains, sanitary sewers, streams, or waterways, any waste material. Remove all wastes from the site and dispose of in a manner complying with applicable ordinances and laws.

B. Smoke Prevention:

1. Strictly observe all air pollution control regulations.
2. Open fires will be allowed only if permitted under current ordinances.

C. Noises:

1. In accordance with the COUNTY's Noise Ordinance, maintain acceptable noise levels in the vicinity of the Work. Limit noise production to acceptable levels by using special mufflers, barriers, enclosures, equipment positioning, and other approved methods.
2. Supply written notification to the County Manager or designee sufficiently in advance of the start of any work that violates this provision. Proceed only when all applicable authorizations and variances have been obtained in writing.

D. Hours of Operation:

1. Operation of construction equipment is only permitted Monday through Saturday, 7:00 AM to 7:00 PM. Obtain written consent from the County Manager or designee for operation of construction equipment during any other period.
2. Do not carry out non-emergency work, including equipment moves, on Sundays without prior written authorization by the County Manager or designee.

E. Dust Control:

1. Take measures to prevent unnecessary dust. Keep earth surfaces exposed to dusting moist with water or a chemical dust suppressant. Cover materials in piles or while in transit to prevent blowing or spreading dust.
2. Adequately protect buildings or operating facilities that may be affected adversely by dust. Protect machinery, motors, instrument panels, or similar equipment by suitable dust screens. Include proper ventilation with dust screens.

F. Temporary Drainage Provisions:

1. Provide for the drainage of stormwater and any water applied or discharged on the site in performance of the Work. Provide adequate drainage facilities to prevent damage to the Work, the site, and adjacent property.
2. Supplement existing drainage channels and conduits as necessary to carry all increased runoff from construction operations. Construct dikes as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect the COUNTY's facilities and the Work, and to direct water to drainage channels or conduits. Provide ponding as necessary to prevent downstream flooding.
3. Maintain excavations free of water. Provide, operate, and maintain pumping equipment. Dewater trenches in accordance with Sections 312319 and 330518.

- G. Pollution: Prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris, and other substances resulting from construction activities. Do not permit sanitary wastes to enter any drain or watercourse other than sanitary sewers. Do not permit sediment, debris, or other substances to enter sanitary sewers. Take reasonable measures to prevent such materials from entering any drain or watercourse.

1.10 TRAFFIC REGULATION

- A. Parking: Provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the Contract, to avoid any need for parking personal vehicles where they may interfere with public traffic or construction activities.
- B. Access: Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian. Provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, give reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when the CONTRACTOR has obtained permission from the owner or tenant of private property, or from the authority having jurisdiction over the public property involved, to obstruct traffic at the designated point.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 015526

TRAFFIC REGULATION AND PUBLIC SAFETY

PART 1 GENERAL

1.1 SECTION INCLUDES:

- A. General Requirements
- B. Traffic Control
- C. Public Safety

1.2 RELATED SECTIONS

- A. Section 015000 – Construction Facilities and Temporary Controls
- B. Section 320117 – Pavement Repair and Restoration
- C. Section 330201 – Roadway Crossings by Open Cut

1.3 GENERAL REQUIREMENTS

- A. Perform all work within COUNTY rights-of-way in strict accordance with the County's Maintenance of Traffic Policy and other applicable statutory requirements to protect the public safety.
- B. Be responsible for providing safe and expeditious movement of traffic through construction zones. A construction zone is defined as the immediate areas of actual construction and all abutting areas which are used by the CONTRACTOR and which interfere with the driving or walking public.
- C. Remove temporary equipment and facilities when no longer required. Restore grounds to original or specified conditions.
- D. The requirements specified herein are in addition to the plan for Maintenance of Traffic as specified in Section 330201.

1.4 TRAFFIC CONTROL

- A. Include as necessary precautions, not to be limited to, such items as proper construction warning signs, signals, lighting devices, marking, barricades, channelization, and hand signaling devices. Be responsible for installation and maintenance of all devices and requirements for the duration of the Construction period.

- B. Provide notice, at least five (5) working days prior to construction, to the State or County Department of Transportation of the necessity to close any portion of a roadway carrying vehicles or pedestrians so that the final approval of such closings can be obtained at least 48 hours in advance. At no time will more than one (1) lane of roadway be closed to vehicles and pedestrians. With any such closings make adequate provision for the safe expeditious movement of each.
- C. Be responsible for notifying Transportation Operations Department, Police, Fire, and other Emergency Departments whenever construction is within roadways and of the alternate routes.
- D. Be responsible for removal, relocation, or replacement of any traffic control device in the construction area that exists as part of the normal pre-construction traffic control scheme.
- E. Immediately notify the County Manager or designee of any vehicular or pedestrian safety or efficiency problems incurred as a result of the construction of the project.
- F. Be responsible for notifying all residents of any road construction and limited access at least 72 hours in advance.

1.5 PUBLIC SAFETY (DURING CONSTRUCTION, ALTERATION OR REPAIR)

- A. In areas of high vehicular traffic, provide a safe walkway around the work area.
- B. Use barricades or other barriers to prevent any possibility of injury to the public caused by the CONTRACTOR's work.
- C. Keep walk areas around the work areas clean of sand, stones, and any other material that could cause a pedestrian accident.
- D. Barricade work areas left overnight. Install flashing warning lights in areas required by the COUNTY.
- E. Unless an approved detour is provided at any open cut crossings, a minimum of one-way traffic will be maintained during the daylight hours and two-way traffic at night. All traffic detours will be restricted to limits of the Right-of-Way with necessary flagmen and/or marking devices. These detours shall be approved by the COUNTY. Detour of traffic outside of the Right-of-Way will be considered with the approval of local governmental agencies and private concerns involved.
- F. Crossing and Intersections: Do not isolate residences and places of business. Provide access to all residences and places of business whenever construction interferes with existing means of access. Maintain access at all times. If pavement is disturbed, a cold mix must be applied at the end of the day.

G. Detours

1. Construct and maintain detour facilities wherever it becomes necessary to divert traffic from any existing roadway or bridge, or wherever construction operations block the flow of traffic. The location of all detours will require prior approval of the COUNTY.
2. Furnishing of Devices and Barriers: Furnish all traffic control devices (including signs), warning devices and barriers. Costs of such devices shall be incidental to construction and included in unit prices bid.
3. Maintenance of Devices and Barriers: Keep traffic control devices, warning devices and barriers in the correct position, properly directed, clearly visible and clean, at all times. Immediately repair replace or clean damaged, defaced or dirty devices or barriers as necessary.

H. Flagmen: Provide certified flagmen (flaggers) to direct traffic where one-way operation in a single lane is in effect and in other situations as may be required. Radios may be required if flagmen cannot maintain contact with each other.

I. Utilize all necessary signs, flagmen, and other safety devices during construction.

J. Perform all work with the requirements set forth by the Occupational Safety Health Administration.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 015713

TEMPORARY EROSION AND SEDIMENTATION CONTROL FOR CONSTRUCTION ACTIVITIES IMPACTING LESS THAN ONE ACRE, INCLUDING CONSTRUCTION REQUIRING DEWATERING

PART 1 GENERAL

1.1 DESCRIPTION

- A. The work specified in this Section consists of designing, providing, maintaining and removing temporary erosion and sedimentation controls as necessary.
- B. Temporary erosion controls include, but are not limited to rip rap channels, road stabilization, grassing, mulching, setting, watering, and reseeding onsite surfaces and spoil and borrow area surfaces and providing interceptor ditches at ends of berms and at those locations which will ensure that erosion during construction will be either eliminated or maintained within acceptable limits as established by the COUNTY.
- C. Temporary sedimentation controls include, but are not limited to; silt dams, traps, barriers, public and private on- and off-site storm sewer inlets protectors, and appurtenances at the foot of sloped surfaces which will ensure that sedimentation pollution will be either eliminated or maintained within acceptable limits as established by the COUNTY.
- D. If required by regulation or COUNTY, CONTRACTOR is responsible for providing an approved Erosion Control Plan for effective temporary erosion and sediment control measures during construction or until final controls become effective.

1.2 REFERENCE DOCUMENTS

- A. South Florida Building Code and Standard Building Code.

PART 2 PRODUCTS

2.1 EROSION CONTROL

- A. Sodding and Seeding is specified in Section 329200.
- B. Rip Rap Channel.
- C. Road Stabilization.

- D. Netting - fabricated of material acceptable to the County Manager or designee.

2.2 SEDIMENTATION CONTROL

- A. Temporary Sediment Trap.
- B. Sediment Fence.
- C. Bales - clean, seed free pine needle or cereal hay type.
- D. Netting - fabricated of material acceptable to the County Manager or designee.
- E. Filter Stone - crushed stone conforming to Florida Department of Transportation specifications.
- F. Concrete Block - hollow, non-load-bearing type.
- G. Concrete - exterior grade not less than one inch thick.

PART 3 EXECUTION

3.1 EROSION CONTROL

- A. Minimum procedures for grassing are:
 - 1. Scarify slopes to a depth of not less than six inches and remove large clods, rock, stumps, roots larger than 1/2 inch in diameter and debris.
 - 2. Sow seed within twenty-four (24) hours after the ground is scarified with either mechanical seed drills or rotary hand seeders.
 - 3. Apply mulch loosely and to a thickness of between 3/4 inch and 1-1/2 inches.
 - 4. Apply netting over mulched areas on sloped surfaces.
 - 5. Roll and water seeded areas in a manner which will encourage sprouting of seeds and growing of grass. Reseed areas that exhibit unsatisfactory growth (less than 70 percent coverage). Backfill and seed eroded areas, removing eroded material from effected drainage facilities.
- B. Minimum procedures for rip rap channel are:
 - 1. Clear the foundation of all trees, stumps, and roots.

2. Excavate the bottom and sides of the channel 30 inches below grade at all points to allow for the placement of riprap as shown in the typical cross-section in the Standard Details.
3. Install extra strength filter fabric on the bottom and sides of the channel foundation, placing the upstream fabric over the downstream fabric with at least a 1 foot overlap on all joints. The fabric is to be securely held in place with metal pins.
4. Place riprap evenly to the lines and grades shown on the drawings and staked in the field. Place riprap immediately following the installation of the filter fabric.
5. Riprap shall meet the specification for F.D.O.T. Class 2 Riprap.
6. Restore all disturbed areas in accordance with a vegetation plan submitted in advance and approved by the County Manager or designee.

C. Minimum Procedures for road stabilization are:

1. Clear roadbed and parking areas of all vegetation, roots and other objectionable material.
2. Provide surface drainage.
3. Spread 6 inch course of lime rock evenly over the full width of road and parking area and smooth to avoid depressions.
4. After grading, seed or resod all disturbed areas adjoining roads and parking areas conforming to existing conditions prior to construction.

3.2 SEDIMENTATION CONTROL

A. Install and maintain silt dams, traps, barriers, and appurtenances as required. Replace deteriorated hay bales and dislodged filter stone.

B. Minimum requirements for sediment trap:

1. Clear, grub and strip the area under the embankment of all vegetation and root mat.
2. Clear retention area to elevation as approved by the County Manager or designee.
3. Use fill material free of roots, woody vegetation and organic matter. Place fill in lifts not to exceed 9 inches and machine compact.

4. Construct dam and stone spillway to dimensions, slopes and elevations shown.
5. Ensure that the spillway crest is level and at least 18 inches below the top of the dam at all points.
6. Stone used for spillway section - Class "B" erosion control stone.
7. Stone used on inside spillway face to control drainage - #67 washed stone.
8. Extend stone outlet section to vegetated road ditch on zero grade with top elevation of stone level with bottom of drain.
9. Ensure that the top of the dam at all points is 6 inches above natural surrounding ground.
10. Stabilize the embankment and all disturbed area above the sediment pools as shown in the vegetation plan.

C. Minimum requirements for sediment fence:

1. Construct sediment fence on low side of topsoil stockpile to prevent sediment from being washed into the drainage system. Fence to extend around approximately 70 percent of the perimeter of the stockpile. Fence must be unobstructed so as to maintain a minimum of 75 percent of its design flow rate.
2. Locate posts down slope of fabric to help support fencing.
3. Bury toe of fence approximately 8 inches deep to prevent undercutting.
4. When joints are necessary, securely fasten the fabric at a support post with overlap to the next post.
5. Filter fabric shall be of nylon, polyester, propylene or ethylene yarn with extra strength – 50 pounds per linear inch (minimum) - and with a flow rate of at least 0.30 gallons per foot per minute. Fabric should contain ultraviolet ray inhibitors and stabilizers.
6. Post to be 4-inch diameter pine with a minimum length of 4 feet.

D. Minimum Requirement for stormwater facilities protection:

1. Public and private stormsewer facilities, both on and offsite, shall be protected at all inlets affected by construction. Stormsewer facilities include streets, inlets, pipes, ditches, swales, canals, culverts, control structures, and detention/retention areas.
2. Grated drop inlets shall be rapped with filter fabric in a manner that allows removal of accumulated sediment from the fabric before removing the grate.
3. Curb inlets shall be protected from sediment, turbid water from stormwater or dewatering activities; also construction debris, concrete mix and rinsate, and any other pollution.
4. Stormwater runoff entering such stormsewer inlets and stormwater detention/retention facilities with a turbidity greater than 50 NTU shall be considered to be in non-compliance with these regulations.

3.3 PERFORMANCE

- A. Should any of the temporary erosion and sediment control measures employed fail to produce results which comply with the requirements of the State of Florida, immediately take steps necessary to correct the deficiency at no expense to the COUNTY. Sedimentation or turbid water violations to stormwater facilities on or offsite shall require the contractor to remove all sediment from the affected facilities.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 016100
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description
- B. Substitutions
- C. Manufacturer's Written Instructions
- D. Transportation and Handling
- E. Storage, Protection and Maintenance
- F. Manufacturer's Field Quality Control Services
- G. Post Startup Services
- H. Special Tools and Lubricating Equipment
- I. Lubrication

1.2 DESCRIPTION

- A. Proposed Manufacturers List: Within 15 calendar days of the date of the Notice to Proceed, submit to the ENGINEER a list of the names of proposed manufacturers, material men, suppliers and subcontractors, obtain approval of this list by the County Manager or designee prior to submission of any working drawings. Upon request submit evidence to ENGINEER that each proposed manufacturer has manufactured a similar product to the one specified and that it has previously been used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.
- B. All material and equipment designed or used in connection with a potable (drinking) water system shall conform to the requirements of the National Sanitation Foundation (NSF) Standard 61, "Drinking Water System Components – Health Effects."
- C. Furnish and install Material and Equipment which meets the following:
 - 1. Conforms to applicable specifications and standards.

2. Complies with size, make, type, and quality specified or as specifically approved, in writing, by ENGINEER.
3. Will fit into the space provided with sufficient room for operation and maintenance access and for properly connecting piping, ducts and services, as applicable. Make the clear spaces that will be available for operation and maintenance access and connections equal to or greater than those shown and meeting all the manufacturers' requirements. If adequate space is not available, the CONTRACTOR shall advise the ENGINEER for resolution.
4. Manufactured and fabricated in accordance with the following:
 - a. Design, fabricate, and assemble in accordance with best engineering and shop practices.
 - b. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.
 - c. Provide two or more items of same kind identical, by same manufacturer.
 - d. Provide materials and equipment suitable for service conditions.
 - e. Adhere to equipment capabilities, sizes, and dimensions shown or specified unless variations are specifically approved, in writing, in accordance with the Contract Documents.
 - f. Adapt equipment to best economy in power consumption and maintenance. Proportion parts and components for stresses that may occur during continuous or intermittent operation, and for any additional stresses that may occur during fabrication or installation.
 - g. Working parts are readily accessible for inspection and repair, easily duplicated and replaced.
5. Use material or equipment only for the purpose for which it is designed or specified.

1.3 SUBSTITUTIONS

A. Substitutions:

1. Make any CONTRACTOR's requests for changes in equipment and materials from those required by the Contract Documents in writing, for approval by the COUNTY. Such requests are considered requests for substitutions and are subject to CONTRACTOR's representations and review provisions of the Contract Documents when one of following conditions are satisfied:

- a. Where request is directly related to an "or County approved equal" clause or other language of same effect in Specifications.
- b. Where required equipment or material cannot be provided within Contract Time, but not as result of CONTRACTOR's failure to pursue Work promptly or to coordinate various activities properly.
- c. Where required equipment or material cannot be provided in manner compatible with other materials of Work, or cannot be properly coordinated therewith.

2. CONTRACTOR'S Options:

- a. Where more than one choice is available as options for CONTRACTOR's selection of equipment or material, select option compatible with other equipment and materials already selected (which may have been from among options for other equipment and materials).
- b. Where compliance with specified standard, code or regulation is required, select from among products that comply with requirements of those standards, codes, and regulations.
- c. Or County approved Equal: For equipment or materials specified by naming one or more equipment manufacturer(s) and "or County approved equal", submit request for substitution for any equipment or manufacturer not specifically named.

B. Conditions Which are Not Substitution:

- 1. Requirements for substitutions do not apply to CONTRACTOR options on materials and equipment provided for in the Specifications.
- 2. Revisions to Contract Documents, where requested by the County Manager or designee or ENGINEER, are "changes" not "substitutions".
- 3. CONTRACTOR's determination of and compliance with governing regulations and orders issued by governing authorities do not constitute substitutions and do not constitute basis for a Change Order, except as provided for in Contract Documents.

1.4 MANUFACTURER'S WRITTEN INSTRUCTIONS

- A. Instruction Distribution: When the Contract Documents require that installation, storage, maintenance and handling of equipment and materials comply with manufacturer's written instructions, obtain and distribute printed copies of such instructions to parties involved in installation, including six copies to ENGINEER.

1. Maintain one set of complete instructions at jobsite during storage and installation, and until completion of work.
- B. Manufacturer's Requirements: Store, maintain, handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's written instructions and in conformity with Specifications.
 1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult ENGINEER for further instructions.
 2. Do not proceed with work without written instructions.
- C. Performance Procedures: Perform work in accordance with manufacturer's written instructions. Do not omit preparatory steps or installation procedures, unless specifically modified or exempted by Contract Documents.

1.5 TRANSPORTATION AND HANDLING

- A. Coordination with Schedule: Arrange deliveries of materials and equipment in accordance with Construction Progress Schedules. Coordinate to avoid conflict with work and conditions at site.
 1. Deliver materials and equipment in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
 2. Protect bright machined surfaces, such as shafts and valve faces, with a heavy coat of grease prior to shipment.
 3. Immediately upon delivery, inspect shipments to determine compliance with requirements of Contract Documents and approved submittals and that material and equipment are protected and undamaged.
- B. Handling: Provide equipment and personnel to handle material and equipment by methods recommended by manufacturer to prevent soiling or damage to materials and equipment or packaging.

1.6 STORAGE, PROTECTION, AND MAINTENANCE

- A. On-site storage areas and buildings:
 1. Conform storage buildings to requirements of Section 015000.
 2. Coordinate location of storage areas with ENGINEER and the COUNTY.
 3. Arrange on site storage areas for proper protection and segregation of stored materials and equipment with proper drainage. Provide for safe

travel around storage areas and safe access to stored materials and equipment.

4. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.
5. Store materials such as pipe, reinforcing and structural steel, and equipment on pallets, blocks or racks, off ground.
6. PVC Pipe may be damaged by prolonged exposure to direct sunlight, take necessary precautions during storage and installation to avoid this damage. Store pipe under cover, and install with sufficient backfill to shield it from the sun.
7. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

B. Interior Storage:

1. Store materials and equipment in accordance with manufacturer's instructions, with seals and labels intact and legible.
2. Store materials and equipment, subject to damage by elements, in weathertight enclosures.
3. Maintain temperature and humidity within ranges required by manufacturer's instructions.

C. Accessible Storage: Arrange storage in a manner to provide easy access for inspection and inventory. Make periodic inspections of stored materials or equipment to assure that materials or equipment are maintained under specified conditions and free from damage or deterioration.

1. Perform maintenance on stored materials of equipment in accordance with manufacturer's instructions, in presence of the County Manager or designee or ENGINEER.
2. Submit a report of completed maintenance to ENGINEER with each Application for Payment.
3. Failure to perform maintenance, to notify ENGINEER of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

- D. COUNTY's Responsibility: The COUNTY assumes no responsibility for materials or equipment stored in buildings or on-site. CONTRACTOR assumes full responsibility for damage due to storage of materials or equipment.
- E. CONTRACTOR's Responsibility: For COUNTY Capital Improvement Projects, the CONTRACTOR assumes full responsibility for protection of completed construction until facilities (or portions of facilities) are accepted for operation and placed in service. Repair and restore damage to completed Work equal to its original condition.
- F. Special Equipment: Use only rubber tired wheelbarrows, buggies, trucks, or dollies to wheel loads over finished floors, regardless if the floor has been protected or not. This applies to finished floors and to exposed concrete floors as well as those covered with composition tile or other applied surfacing.
- G. Surface Damage: Where structural concrete is also the finished surface, take care to avoid marking or damaging surface.

1.7 MANUFACTURER'S FIELD QUALITY CONTROL SERVICES

- A. General:
 - 1. Provide manufacturer's field services in accordance with this subsection for those tasks specified in other sections.
 - 2. Include and pay all costs for suppliers' and manufacturers' services, including, but not limited to, those specified.
- B. Installation Instruction: Provide instruction by competent and experienced technical representatives of equipment manufacturers or system suppliers as necessary to resolve assembly or installation procedures that are attributable to, or associated with, the equipment furnished.
- C. Installation Inspection, Adjustments and Startup Participation:
 - 1. Provide competent and experienced technical representatives of equipment manufacturers or system suppliers to inspect the completed installation as follows.
 - a. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions that may cause damage.
 - b. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

- c. Verify that wiring and support components for equipment are complete.
 - d. Verify that equipment or system is installed in accordance with the manufacturer's recommendations, approved shop drawings and the Contract Documents.
 - e. Verify that nothing in the installation voids any warranty.
2. Provide manufacturer's representatives to perform initial equipment and system adjustment and calibration conforming to the manufacturer's recommendations and instructions, approved shop drawings and the Contract Documents.
 3. Start-up of Equipment: Provide prior written notice of proposed start-up to the County Manager or designee and ENGINEER. Obtain ENGINEER's approval before start-up of equipment. COUNTY's departmental representative must be on-site during start-up. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.
 4. Furnish ENGINEER with three copies of the following. When training is specified, furnish the copies at least 48 hours prior to training.
 - a. "Certificate of Installation, Inspection and Start-up Services" by manufacturers' representatives for each piece of equipment and each system specified, certifying:
 - (1) That equipment is installed in accordance with the manufacturers' recommendations, approved shop drawings, and the Contract Documents.
 - (2) That nothing in the installation voids any warranty.
 - (3) That equipment has been operated in the presence of the manufacturer's representative.
 - (4) That equipment, as installed, is ready to be operated by others.
 - b. Detailed report by manufacturers' representatives, for review by ENGINEER of the installation, inspection and start-up services performed, including:
 - (1) Description of calibration and adjustments if made; if not in Operation and Maintenance Manuals, attach copy.
 - (2) Description of any parts replaced and why replaced.

- (3) Type, brand name, and quantity of lubrication used, if any.
 - (4) General condition of equipment.
 - (5) Description of problems encountered, and corrective action taken.
 - (6) Any special instructions left with CONTRACTOR or ENGINEER.
- D. Field Test Participation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to participate in field testing of the equipment specified in Section 014500.
- E. Trouble-Free Operation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to place the equipment in trouble-free operation after completion of start-up and field tests.

1.8 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

- A. General: Furnish, per manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)
- B. Time of Delivery: Deliver special tools and lubricating equipment to the COUNTY when unit is placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.
- C. Quality: Provide tools and lubricating equipment of a quality meeting equipment manufacturer's requirements.

1.9 LUBRICATION

- A. General: Where lubrication is required for proper operation of equipment, incorporate in the equipment the necessary and proper provisions in accordance with manufacturer's requirements. Where possible, make lubrication automated and positive.
- B. Oil Reservoirs: Where oil is used, supply reservoir of sufficient capacity to lubricate unit for a 24-hour period.

1.10 WARRANTY

- A. Provide copies of any warranties of materials or equipment to the County Manager or designee with documentation showing compliance with warranty requirements.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

CERTIFICATE OF INSTALLATION, INSPECTION AND START-UP SERVICES

Project _____

Equipment _____

Specification Section _____

Contract _____

I hereby certify that the named equipment has been inspected, adjusted and operated by the Manufacturers' Representative and further certify:

1. That the equipment is installed in accordance with the manufacturer's recommendations, approved shop drawings, and the Contract Documents.
2. That nothing in the installation voids any warranty.
3. That equipment has been operated in the presence of the manufacturer's representative.
4. That equipment, as installed, is ready to be operated by others.

MANUFACTURERS' REPRESENTATIVE

Signature _____ Date _____

Name (print) _____

Title _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

Attach the detailed report called for by Specification Section 016100.

Complete and submit three copies of this form with the detailed report to ENGINEER as specified.

CERTIFICATE OF POST START-UP SERVICES

Project _____

Equipment _____

Specification Section _____

Contract _____

I hereby certify the Manufacturers' Representative has inspected this equipment, made adjustments and calibrations, and that it is operating in conformance with the design, specifications, and manufacturer's requirements. Detailed notation of improper operation with corresponding recommendations, if any, are made and attached to this form.

MANUFACTURERS' REPRESENTATIVE

Signature _____ Date _____

Name (print) _____

Title _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

ENGINEER

Signature _____ Date _____

Name (print) _____

Title _____

Complete and submit three copies of this form to the County Manager or designee upon completion of 6 to 11 months reinspection as required by Specification Section 016100.

END OF SECTION

SECTION 017300

MISCELLANEOUS WORK AND CLEANUP

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. This Section includes operations that cannot be specified in detail as separate items but can be sufficiently described as to the kind and extent of work involved. Furnish all labor, materials, equipment and incidentals to complete the work under this Section.
- B. The work of this Section includes, but is not limited to, the following:
 - 1. Restoring of sidewalks, driveways, curbing and gutters.
 - 2. Crossing utilities.
 - 3. Relocation of existing water lines, low pressure, gas lines, telephone lines, electric lines, cable TV lines and storm drains as necessary, all as shown on the drawings.
 - 4. Restoring easements and rights-of-ways.
 - 5. Cleaning up.
 - 6. Incidental work.

1.2 WORK SPECIFIED UNDER OTHER SECTIONS

- A. Complete all work in a workmanlike manner by competent workmen in full compliance with all applicable sections of these Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Materials required for this Section shall be of at least the same type and quality as materials that are to be restored. Where possible, reuse existing materials that are removed and then replaced, with the exception of paving.

PART 3 EXECUTION

3.1 RESTORING OF CURBING, FENCES, AND GUARD RAILS

- A. Protect existing curbing. If necessary, remove curbing from joint to joint and replace after backfilling. Replace curbing that is damaged during construction with curbing of equal quality and dimension.

3.2 CROSSING UTILITIES

- A. This item shall include any extra work required in crossing culverts, water courses, drains, water mains, and other utilities, including all sheeting and bracing, extra excavation and backfill, or any other work required for the crossing, whether or not shown on the drawings.

3.3 RELOCATIONS OR REPLACEMENT OF EXISTING GAS LINES, TELEPHONE LINES, ELECTRIC LINES, CABLE TV LINES AND DRAINAGE CULVERT

- A. Notify the proper authority of the utility involved when relocation or replacement of these lines is required. Coordinate all work by the utility so that the progress of construction will not be hampered.
- B. Reference all side drains, side ditches, swales, and storm sewers as to grade and location prior to construction, maintain them during construction, and repair them as necessary after construction. Where drainage structures are disturbed and must be replaced, the minimum size replacement shall be twelve inches (12"). All drainage culverts installed shall have mitered ends in conformance with the Collier County Standard Details. Place the culvert to the specified elevations and regrade or reshape the swale and road shoulders that have been disturbed or damaged during construction.

3.4 PROTECTION AND RESTORATION OF PROPERTY

- A. Protection and Restoration of Property: During the course of construction, take special care and provide adequate protection in order to minimize damage to vegetation, surfaced areas, and structures within the construction right-of-way, easement or site, and take full responsibility for the replacement or repair thereof. Immediately repair any damage to private property created by encroachment thereon. Should the removal or trimming of valuable trees, shrubs, or grass be required to facilitate the installation within the designated construction area, this work shall be done in cooperation with the County and/or local communities which the work takes place. Said valuable vegetation, removed or damaged, shall be replanted, if possible, or replaced by items of equal quality, and maintained until growth is re-established. Topsoil damaged in the course of work shall be replaced in kind with suitable material, graded to match existing grade. Following construction completion, the work area along the route of the installation shall be finish grade to elevations compatible with the adjacent surface, with grassing or hand raking required within developed areas.

- B. Existing lawn surfaces damaged by construction shall be re-graded and re-sodded or re-seeded. These areas shall be maintained until all work under this Contract has been completed and accepted.

3.5 CLEANING UP

- A. Remove all construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations and shall render the site of the work in a neat and orderly condition.
- B. Work site clean-up shall follow construction operations without delay and in accordance with Section 017423.

3.6 INCIDENTAL WORK

- A. Do all incidental work not otherwise specified, but obviously necessary for the proper completion of the Contract as specified and as shown on the drawings.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 017416

SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for clearing of all areas within the Contract limits and other areas shown, including work designated in permits and other agreements, in accordance with the requirements of Division 1.
- B. Related Work Specified in Other Sections Includes:
 - 1. Section 024100 – Demolition
 - 2. Section 312316 - Excavation - Earth and Rock
 - 3. Section 312323 – Backfilling
 - 4. Section 329200 – Restoration by Sodding or Seeding

1.2 DEFINITIONS

- A. Clearing: Clearing is the removal from the ground surface and disposal, within the designated areas, of trees, brush, shrubs, down timber, decayed wood, other vegetation, rubbish and debris as well as the removal of fences.
- B. Grubbing: Grubbing is the removal and disposal of all stumps, buried logs, roots larger than 1-1/2 inches, matted roots and organic materials.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PROTECTION OF EXISTING UTILITIES

- A. Prior to site clearing, locate and mark all existing utilities in coordination with the COUNTY and other affected owners. Protect all existing utilities and markings from damage. In case of damage to existing utilities caused by construction activities, contact the owner of the utility or appropriate COUNTY department (Water or Wastewater) immediately. Repair any damage to existing utilities or markings caused by construction activities in coordination with or as directed by the owner of the utility.

3.2 TREE REMOVAL

- A. Tree Removal Within Right-of-Way Limits: Remove trees and shrubs within the right-of-way unless otherwise indicated.
 - 1. Remove trees and shrubs to avoid damage to trees and shrubs designated to remain.
 - 2. Grub and remove tree stumps and shrubs felled within the right-of-way to an authorized disposal site. Fill depressions created by such removal with material suitable for backfill as specified in Section 312323.
- B. Tree Removal Outside Right-of-Way Limits: Do not cut or damage trees outside the right-of-way unless plans show trees to be removed or unless written permission has been obtained from the property owner. Furnish three copies of the written permission before removal operations commence.
- C. If the landowner desires the timber or small trees, cut and neatly pile it in 4 foot lengths for removal by the owner; otherwise, dispose of it by hauling it away from the project site. If hauled timber is of merchantable quality, credit shall accrue to the CONTRACTOR.

3.3 TREES AND SHRUBS TO BE SAVED

- A. Protection: Protect trees and shrubs within the work limits that are so delineated or are marked in the field to be saved from defacement, injury and destruction.
 - 1. Work within the limits of the tree drip line with extreme care using either hand tools or equipment that will not cause damage to trees.
 - a. Do not disturb or cut roots unnecessarily. Do not cut roots 1-1/2 inches and larger unless approved.
 - b. Immediately backfill around tree roots after completion of construction in the vicinity of trees.
 - c. Do not operate any wheeled or tracked equipment within drip line.
 - 2. Protect vegetation from damage caused by emissions from engine-powered equipment.
 - 3. During working operations, protect the trunk, foliage and root system of all trees to be saved with boards or other guards placed as shown and as required to prevent damage, injury and defacement.
 - a. Do not pile excavated materials within the drip line or adjacent to the trunk of trees.

- b. Do not allow runoff to accumulate around trunk of trees.
 - c. Do not fasten or attach ropes, cables, or guy wires to trees without permission. When such permission is granted, protect the tree before making fastening or attachments by providing burlap wrapping and softwood cleats.
 - d. The use of axes or climbing spurs for trimming will not be permitted.
 - e. Provide climbing ropes during trimming.
4. Remove shrubs to be saved, taking a sufficient earth ball with the roots to maintain the shrub.
- a. Temporarily replant if required, and replace at the completion of construction in a condition equaling that which existed prior to removal.
 - b. Replace in kind if the transplant fails.
5. Have any tree and shrub repair performed by a tree surgeon properly licensed by the State of Florida and within 24 hours after damage occurred.

3.4 CLEARING AND GRUBBING

- A. Clearing: Clear all items specified to the limits shown and remove cleared and grubbed materials from the site.
- 1. Do not start earthwork operations in areas where clearing and grubbing is not complete, except that stumps and large roots may be removed concurrent with excavation.
 - 2. Comply with erosion, sediment control and storm management measures as specified in Division 1.
- B. Grubbing: Clear and grub areas to be excavated, areas receiving less than 3 feet of fill and areas upon which structures are to be constructed.
- 1. Remove stumps and root mats in these areas to a depth of not less than 18 inches below the subgrade of sloped surfaces.
 - 2. Fill all depressions made by the removal of stumps or roots with material suitable for backfill as specified in Section 312323.
- C. Limited Clearing: Clear areas receiving more than 3 feet of fill by cutting trees and shrubs as close as practical to the existing ground. Grubbing will not be required.

- D. Dispose of all material and debris from the clearing and grubbing operation by hauling such material and debris away to an approved dump. The cost of disposal (including hauling) of cleared and grubbed material and debris shall be considered a subsidiary obligation of the CONTRACTOR; include the cost in the bid for the various classes of work.

3.5 TOPSOIL

- A. Stripping: Strip existing topsoil from areas that will be excavated or graded prior to commencement of excavating or grading and place in well-drained stockpiles in approved locations.

END OF SECTION

SECTION 017423

CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES:

- A. General Requirements
- B. Disposal Requirements

1.2 GENERAL REQUIREMENTS

- A. Execute cleaning during progress of the work and at completion of the work.

1.3 DISPOSAL REQUIREMENTS

- A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 DURING CONSTRUCTION

- A. Execute daily cleaning to keep the work, the site, and adjacent properties free from accumulations of waste materials, rubbish, and windblown debris, resulting from construction operations.
- B. Provide onsite containers for the collection of waste materials, debris and rubbish. All waste materials including containers, food debris and other miscellaneous materials must be disposed of daily in onsite containers.
- C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

3.2 FINAL CLEANING

- A. Requirements: At the completion of work and immediately prior to final inspection, clean the entire project as follows:
 - 1. Thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. Leave the structures and site in a complete and finished condition to the satisfaction of the ENGINEER.
 - 2. Direct all subcontractors to similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.
 - 3. Remove all temporary structures and all debris, including dirt, sand, gravel, rubbish and waste material.
 - 4. Should the CONTRACTOR not remove rubbish or debris or not clean the buildings and site as specified above, the OWNER reserves the right to have the cleaning done at the expense of the CONTRACTOR.
- B. Employ experienced workers, or professional cleaners, for final cleaning.
- C. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
- D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.
- E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.
- F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.
- G. Replace air-handling filters if units were operated during construction.
- H. Clean ducts, blowers, and coils, if air-handling units were operated without filters during construction.
- I. Vacuum clean all interior spaces, including inside cabinets.
- J. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.
- K. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

- L. Clean interior of all panel cabinets, pull boxes, and other equipment enclosures.
- M. Wash and wipe clean all lighting fixtures, lamps, and other electrical equipment that may have become soiled during installation.
- N. Perform touch-up painting.
- O. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.
- P. Remove erection plant, tools, temporary structures and other materials.
- Q. Remove and dispose of all water, dirt, rubbish or any other foreign substances.

3.3 FINAL INSPECTION

- A. After cleaning is complete the final inspection may be scheduled. The inspection will be done with the OWNER and ENGINEER.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 017823

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description
- B. Quality Assurance
- C. Format and Contents

1.2 DESCRIPTION

- A. Scope: Furnish to the ENGINEER three (3) printed copies and one (1) electronic copy of an Operation and Maintenance Manual for all equipment and associated control systems furnished and installed.

1.3 QUALITY ASSURANCE

- A. Reference Codes and Specifications: No current government or commercial specifications or documents apply.

1.4 FORMAT AND CONTENTS

- A. Prepare and arrange each copy of the manual as follows:
 - 1. One copy of an equipment data summary (see sample form) for each item of equipment.
 - 2. One copy of an equipment preventive maintenance data summary (see sample form) for each item of equipment.
 - 3. One copy of the manufacturer's operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts. Include Manufacturer's telephone numbers for Technical Support.
 - 4. List of electrical relay settings and control and alarm contact settings.
 - 5. Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems.

6. One valve schedule giving valve number, location, fluid, and fluid destination for each valve installed. Group all valves in same piping systems together in the schedule. Obtain a sample of the valve numbering system from the ENGINEER.
 7. Furnish all O&M Manual material on 8-1/2 by 11 commercially printed or typed forms or an acceptable alternative format.
- B. Organize each manual into sections paralleling the equipment specifications. Identify each section using heavy section dividers with reinforced holes and numbered plastic index tabs. Use 3-ring, hard-back binders. Punch all loose data for binding. Arrange composition and printing so that punching does not obliterate any data. Print on the cover and binding edge of each manual the project title, and manual title, as furnished and approved by the ENGINEER.
 - C. Leave all operating and maintenance material that comes bound by the equipment manufacturer in its original bound state. Cross-reference the appropriate sections of the CONTRACTOR's O&M manual to the manufacturers' bound manuals.
 - D. Label binders Volume 1, 2, and so on, where more than one binder is required. Include the table of contents for the entire set, identified by volume number, in each binder.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

Collier County Utilities

Equipment Data Summary

Equipment Name:		Specification Reference:	
Manufacturer:			
	Name:		
	Address:		
	Telephone:		
Number Supplied:		Location/Service:	
Model No:		Serial No:	
Type:			
Size/Speed/Capacity/Range (as applicable):			
Power Requirement (Phase/Volts/Hertz):			
Local Representative:			
	Name:		
	Address:		
	Telephone:		
NOTES:			

Collier County Utilities

Preventive Maintenance Summary

Equipment Name:		Location:	
Manufacturer:			
Name:			
Address:			
Telephone:			
Model No:		Serial No:	
Maintenance Task	Lubricant/Part	D W M Q SA A	O&M Manual Reference
NOTES:			

*D-Daily W-Weekly M-Monthly Q-Quarterly SA-Semi-Annual A-Annual

SECTION 017839

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

Requirements for preparation, maintenance and submittal of project record documents. The Contractor's attention is specifically directed to Part 3.2.B. of this Section, which requires use of a Florida licensed surveyor to sign and seal all record drawings.

1.2 RELATED SECTIONS

- A. Section 014500 – Quality Control
- B. Section 022100 – Lines and Grades

1.3 SUBMITTALS

- A. General: Provide all submittals as specified.
- B. At Contract close out, three (3) sets of signed and sealed Record Drawings for the potable water OR non-potable irrigation water OR wastewater systems to be conveyed shall be submitted to the County or District. If potable water AND wastewater, AND/OR non-potable irrigation water systems or portion(s) thereof are being conveyed, five (5) sets of signed and sealed Record Drawings shall be submitted to the County.
- C. Provide electronic submittal as specified in Part 3.2.B of this Section.

1.4 REQUIREMENTS (For County Capital Projects Only)

Contractor shall maintain at the site for the County one record copy of:

- A. Drawings
- B. Specifications
- C. Addenda
- D. Change orders and other modifications to the Contract
- E. Design Engineer's field orders or written instructions
- F. Approved shop drawings, working drawings and samples
- G. Field test records

PART 2 PRODUCTS (not used)

PART 3 EXECUTION

3.1 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Project record documents shall be stored in Contractor's field office or other location approved by the County apart from documents used for construction
- B. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
- C. Make documents and samples available at all times for inspection by the County.

3.2 RECORDING

A. General

- 1. Record Drawings shall accurately depict the constructed configuration of all potable water, non-potable irrigation water and/or wastewater systems or portion(s) thereof. All revisions to County staff approved construction drawings shall be precisely identified and illustrated on the Record Drawings. All Record Drawings of utility systems or portion(s) thereof that are not being conveyed to the Board shall bear, on the cover sheet, a prominently displayed DISCLAIMER, in bold lettering at least one-quarter (1/4) inch high, stating: "All on-site potable water, non-potable irrigation and/or wastewater systems shall be owned, operated and maintained by the private owner(s) and/or the master condominium/homeowners' association, successors or assigns" (or other comparable private ownership).
- 2. Label each document "PROJECT RECORD" or similar text in neat, large printed letters.
- 3. Survey information can be obtained as needed by the use of 2-inch PVC labeled pipes installed over underground improvements by the contractor during construction. This method is an adequate process for obtaining record information.
- 4. Record information in red ink.

B. Record Drawings

- 1. The Record Drawings require signed and sealed as-built information, including above and below ground improvements including underground piping, valves and ductbanks, by a Florida Licensed Land Surveyor.
- 2. The Record Drawings shall identify the entity that provided the record data.
- 3. Drawings shall be referenced to and tie-in with the state plane coordinate system, with a Florida East Projection, and a North American Datum 1983/1990 (NAD 83/90 datum), and with United States Survey Feet (USFEET) units, and North American Vertical Datum 1988 (NAVD 88), as established by a registered Florida surveyor and mapper.

4. Files shall be also submitted in two digital file formats, specifically Drawing File (DWG) format in AutoCAD Release 2004 or later version as well as PDF format (latest version).
5. Record drawings shall be submitted to the County staff within 60 days of the final construction completion date.
6. The following items shall be accurately depicted in vertical and horizontal directions on the Record Drawings:
 - a) All associated rights-of-way and utility easements whether shown on the Contract Drawings, found during construction or added during the Work.
 - b) Sewer system inverts, pipe slopes, manhole rims and run lengths.
 - c) Sewer lateral locations stationed from the nearest downstream manhole.
 - d) Sewer main stub extension inverts at both ends, pipe slope, run length and location.
 - e) Tie-ins to all valves, air release assemblies, fire hydrants, manholes, blowoffs, etc.
 - f) Top elevations of treatment plant structures and tanks.
 - g) Manhole center for sanitary sewers and storm sewers as related to utility improvements.
 - h) Pipe changes in direction or slope.
 - i) Buried valves, tees and fittings.
 - j) Pipe invert, or centerline, elevations at crossing with other pipe.
 - k) Invert, or centerline, elevations and coordinates of existing exposed pipe at crossing with underground pipe installed under this project.
 - l) Other horizontal and vertical record data pertinent to completed Work.
 - m) Water meter box locations.
 - n) Locations of direct bury, conduits, handholes, junction boxes and vaults for buried electric and communication cables that will be conveyed to the County shall be depicted.
7. Each pipe elevation shall be clearly identified as to whether it is top of pipe, centerline of pipe or invert of pipe.
8. For County Capital Projects only, Record Drawings shall indicate all deviations from Contract Drawings including:
 - a) Field changes.
 - b) Changes made by Change Order.
 - c) Details, utilities, piping or structures not on original Contract Drawings.
 - d) Equipment and piping relocations.

C. Specifications and Addenda (For County Capital Projects Only)

Legibly mark each Section to record:

1. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed.
2. Changes made by Field Order or Change Order.

D. Shop Drawings (For County Capital Projects Only)

1. Keep one copy of the final, approved shop drawing with the Record Documents.
2. Record documents should include all shop drawing information submitted. Additional information submitted during the review process should be filed with the appropriate submittal.

END OF SECTION

SECTION 020500
CONNECTIONS TO EXISTING SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General Requirements
- B. Submittals
- C. Scheduling of Shutdown

1.2 RELATED SECTIONS

- A. Section 011000 – Summary of Work
- B. Section 015000 – Construction Facilities and Temporary Controls
- C. Section 015526 – Traffic Regulations and Public Safety
- D. Section 320117 – Pavement Repair and Restoration

1.3 GENERAL REQUIREMENTS

- A. Be responsible for all connection to existing systems, cutting, fitting and patching, including attendant excavation and backfill, required to complete the work or to:
 - 1. Make its several parts fit together properly.
 - 2. Uncover portions of the work to provide for installation of ill-timed work.
 - 3. Remove and replace defective work.
 - 4. Remove and replace work not conforming to requirements of Contract Documents.
- B. Coordination: Before connection is performed, verify and provide for any pipe restraint that may be required for the new connection. Perform all cutting, fitting or patching of the Work that may be required to make the several parts thereof join in accordance with the Contract Documents. Perform restoration with competent workmen skilled in the trade.
- C. If changes to a “looped” water distribution system occurring during construction result in dead ends to any new or relocated water mains, connect such dead

ends to the nearest water main. In cases where no nearby water main is available, provide a flushing device in coordination with the COUNTY at no additional cost to the COUNTY.

- D. Improperly Timed Work: Perform all cutting and patching required to install improperly timed work, to remove samples of installed materials for testing, and to provide for alteration of existing facilities or for the installation of new Work in the existing construction.
- E. Limitations: Except when the cutting or removal of existing construction is specified or indicated, do not undertake any cutting or demolition, which may affect the structural stability of the Work or existing facilities without the ENGINEER's concurrence.
- F. Collier County Damage Prevention Policy:
 - 1. This policy has been put in place to avoid damage to Collier County underground utilities. A minimum distance of five feet (5') horizontally and eighteen inches (18") vertically must be maintained away from Collier County utilities (in accordance with pipe separation criteria located in the Design Criteria section). Any and all variations from this order must be approved by the Water or Wastewater Department.
 - 2. **Before commencement of any excavation, the existing underground utilities in the area affected by the work must be marked by Sunshine One Call, in accordance with State Statute Chapter 556 "Underground Facility Damage Prevention and Safety", after proper notification to them by either calling 811 in Florida or toll free at 1-800-432-4770. Visit www.sunshine811.com for more information. Before commencing excavation for the work, potholing of all potential conflicts must be performed.**
 - 3. All lines in conflict must be physically located by the contractor. Any conflict shall be reported to the utility and Collier County Public Utilities. Utilities under concrete or pavement may require soft dig vacuum locates which also is the contractor's responsibility to perform. All utilities will be field marked per Sunshine State One Call's statutes and guidelines. For line verification or any other information concerning locates, please call the Locate Department at 239-252-5922 during normal business hours. For line verification or emergency locates after hours, call emergency number 239-825-1444. **In the event the potholing and/or vacuum soft dig does not locate the marked utility, work must be stopped and the affected utility owner contacted.** Failure to comply with this policy and obtain required signature(s) may result in revocation of existing right-of-way permits.

1.4 SUBMITTALS

- A. Submit a written request to the ENGINEER well in advance of executing any cutting or alteration which affects:
 - 1. Work of the COUNTY or any separate contractor.
 - 2. Structural value or integrity of any element of the project or work.
 - 3. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 4. Efficiency, operational life, maintenance or safety of operational elements.
 - 5. Visual qualities of sight-exposed elements.
- B. Include in request:
 - 1. Identification of the work.
 - 2. Description of affected work.
 - 3. The necessity for cutting, alteration or excavation.
 - 4. Effect on work of the COUNTY or any separate contract, or on structural or weatherproof integrity of work.
 - 5. Description of proposed work:
 - a. Scope of cutting, patching, alteration, or excavation.
 - b. Trades who will execute the work.
 - c. Products proposed to be used.
 - d. Extent of refinishing to be done.
 - 6. Alternatives to cutting and patching.
 - 7. Cost proposal, when applicable.
 - 8. Written permission of any separate contractor whose work will be affected.
- C. SUBMIT WRITTEN NOTICE TO THE ENGINEER DESIGNATING THE DATE AND THE TIME THE WORK WILL BE UNCOVERED.

1.5 SCHEDULING OF SHUTDOWN

- A. Connections to Existing Facilities: If any connections, replacement, or other work

requiring the shutdown of an existing facility is necessary, schedule such work at times when the impact on the COUNTY's normal operation is minimal. If shutdown involves the water distribution or transmission system, provide notice to the COUNTY Water Department at least two (2) weeks prior to the proposed shutdown, including date, time and anticipated length of interruption of service. Overtime, night and weekend work without additional compensation from the COUNTY, may be required to make these connections, especially if the connections are made at times other than those specified. The connection of new or existing pipelines is prohibited from starting until CONTRACTOR assures that the system can receive the new flow.

- B. Interruptions of Service: Perform cut-ins into lines at a time approved in writing by the County Manager or designee. Whenever it is required to turn off valves which may interrupt the water supply of residents or businesses, notify all concerned parties or agencies with personal contact, door hangers or written notice at least forty-eight (48) hours in advance of such cut-off, after having obtained the approval of the County Manager or designee. Provide a copy of the written notice to the Water Distribution Section by fax. ONLY COUNTY PERSONNEL MAY OPERATE COUNTY-OWNED VALVES. Maintain water service to existing connections during construction, under any and all conditions and at no additional cost to the COUNTY. Thoroughly clean and swab all pipe and fittings for cut-ins with a concentrated solution of calcium hypochlorite.
- C. Request for Water System Shutdowns: When plans call for connection to existing water distribution facilities or the CONTRACTOR plans to shut down existing utilities or where damage to such facilities is likely in order to complete construction of items under this contract, furnish the County Manager or designee with a written request for connection. The COUNTY Water Distribution Section will identify the locations of all water valves needed to isolate the point of connection in the event that the existing facilities are damaged while making the connection. Identify in the request means which the CONTRACTOR proposes to use in order to provide effective shutdown of the system. Include in a connection and shutdown schedule details of shutdown time and duration. No connections to existing utilities – or construction where shutdown of, or damage to, existing utilities may occur – shall commence prior to County Manager or designee approval of the connection and shutdown plan and schedule.
- D. Request for Wastewater Diversion: Submit a request for each diversion necessary during construction to the County Manager or designee and the ENGINEER sufficiently in advance of any required diversion. Identify in the request the valves, bypass piping, portable pumper trucks or any other means which the CONTRACTOR proposes to use in order to provide effective shutdown of the system. Include in a connection and shutdown schedule details of shutdown time and duration. No connections to existing utilities – or construction where shutdown of, or damage to, existing utilities may occur – shall commence prior to County Manager or designee approval of the connection and shutdown plan and schedule.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Comply with specifications and standards for each specific product involved.

PART 3 EXECUTION

3.1 INSPECTION

- A. Inspect existing conditions of projects, including elements subject to damage or to movement during cutting and patching.
- B. After uncovering work, inspect conditions affecting installation of products, or performance of the work.
- C. Report unsatisfactory or questionable conditions to the ENGINEER in writing; do not proceed with work until the ENGINEER has provided further instructions.

3.2 PREPARATION

- A. In cases where service to utility customers is interrupted, provide adequate equipment with backup onsite to assure prompt restoration of service.
- B. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of work.
- C. Provide devices and methods to protect other portions of project from damage.
- D. Provide protection from elements for that portion of the project that may be exposed by cutting and patching work, and maintain excavations free from water.
- E. Material Removal: Cut and remove all materials to the extent shown or as required to complete the work. Remove materials in a careful manner with no damage to adjacent facilities. Remove materials that are not salvageable from the site.

3.3 PERFORMANCE

- A. Execute cutting and demolition by methods that will prevent damage to other work, and will provide proper surfaces to receive installation of repairs.
- B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work.
- C. Employ original installer or fabricator to perform cutting and patching for:
 - 1. Weather-exposed or moisture-resistant elements.
 - 2. Sight-exposed finished surfaces.

- D. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances, and finishes.
- E. Restore work, which has been cut or removed; install new products to provide completed work in accord with requirements of contract documents.
- F. Fit work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- G. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:
 - 1. For continuous surfaces, refinish to nearest intersection.
 - 2. For an assembly, refinish entire unit.

3.4 PAVEMENT RESTORATION

- A. Restore all pavement or roadway surfaces in accordance with Section 320117 – Pavement Repair and Restoration.
- B. Restore, replace or rebuild existing street paving, including underdrains, if any are encountered, where damaged, using the same type of construction as was in the original. Be responsible for restoring all such work, including subgrade, base courses, curb and gutter or other appurtenances where present. The County Manager or designee will obtain the permits listed in the Contract Documents. Obtain and pay for at CONTRACTOR's expense any additional local or other governmental permits as may be required for the opening of streets and be satisfied as to any requirements other than those herein set forth which may affect the type, quality and manner of carrying on the restoration of surfaces by reason of jurisdiction of such governmental bodies.
- C. This section does not describe the construction of new road surfaces or the complete resurfacing of existing pavements.
- D. In all cases, the CONTRACTOR will be required to maintain, without additional compensation, all permanent replacement of street paving, done by him under this Contract for a period of 12 months after the acceptance of the Contract, including the removal and replacement of such work wherever surface depressions or underlying cavities result from settlement of trench backfill.
- E. Perform all the final resurfacing or repaving of streets or roads, over the excavations made and be responsible for relaying paving surfaces of roads that have failed or been damaged at any time before the termination of the maintenance period on account of work done by him. Resurface or repave over any tunnel jacking, or boring excavation that settles or breaks the surface, repave to the satisfaction of the County Manager or designee and at the CONTRACTOR's expense. Conform backfilling of trenches and the preparation of subgrades to the requirements of excavation and backfilling of pipeline trenches.

- F. Where pipeline construction crosses paved streets, driveways or sidewalks, the CONTRACTOR may elect, at no additional cost to the COUNTY, to place the pipe by the jacking and boring, horizontal direction drilling, or tunneling method in lieu of cutting and patching of the paved surfaces. Such work shall be accomplished in accordance with all applicable sections of the Contract Documents.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 022100
LINES AND GRADES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General
- B. Surveys
- C. Datum Plane
- D. Protection of Survey Data

1.2 GENERAL

- A. Construct all work in accordance with the lines and grades shown on the Drawings. Assume full responsibility for keeping all alignment and grade.

1.3 SURVEYS

- A. Reference Points: The COUNTY will provide reference points for the work as described in the General Conditions. Base horizontal and vertical control points will be designated by the ENGINEER and used as datum for the Work. Perform all additional survey, layout, and measurement work.
 - 1. Keep ENGINEER informed, sufficiently in advance, of the times and places at which work is to be performed so that base horizontal and vertical control points may be established and any checking deemed necessary by ENGINEER may be done, with minimum inconvenience to the ENGINEER and at no delay to CONTRACTOR. It is the intention not to impede the Work for the establishment of control points and the checking of lines and grades set by the CONTRACTOR. When necessary, however, suspend working operations for such reasonable time as the ENGINEER may require for this purpose. Costs associated with such suspension are deemed to be included in the Contract Price, and no time extension or additional costs will be allowed.
 - 2. Provide an experienced survey crew including an instrument operator, competent assistants, and any instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement of work performed by the CONTRACTOR.

1.4 DATUM PLANE

- A. All elevations indicated or specified refer to the North American Vertical Datum 1988 (NAVD 88), of the United States Coast and Geodetic Survey and are expressed in feet and decimal parts thereof, or in feet and inches.

1.5 PROTECTION OF SURVEY DATA

- A. General: Safeguard all points, stakes, grade marks, known property corners, monuments, and benchmarks made or established for the Work. Reestablish them if disturbed, and bear the entire expense of checking reestablished marks and rectifying work improperly installed.
- B. Records: Keep neat and legible notes of measurements and calculations made in connection with the layout of the Work. Furnish copies of such data to the ENGINEER for use in checking the CONTRACTOR's layout. Data considered of value to the County Manager or designee will be transmitted to the County Manager or designee by the ENGINEER with other records on completion of the Work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 022200

PRE-CONSTRUCTION AUDIO-VIDEO RECORDING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work specified in this section includes the requirements for pre-construction audio-video recordings necessary to document existing conditions on public and private property.

PART 2 PRODUCTS

2.1 CONTRACTOR REQUIREMENTS

- A. The Contractor shall provide color videos showing pre-construction site conditions of all public and private property within the scope of construction. The videos shall be on DVD and electronic format indicating on the beginning and front of each DVD, the date, job title and location where the video was taken. The videos shall be clear and shall thoroughly document all existing structures and landscaping.
- B. Two copies of the DVD and one electronic copy (on a USB flash drive or other appropriate device) shall be delivered to the County Manager or designee for review.

PART 3 EXECUTION

3.1 INSPECTION

- A. Construction on private property shall not commence until the County Manager or designee has reviewed and approved the audio-video recording.

3.2 PERFORMANCE

- A. The Contractor may be required to restore private properties to conditions better than existing, at no additional cost to the COUNTY, if the Contractor fails to sufficiently document existing conditions.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 022501

LEAKAGE TESTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Testing for any signs of leakage in all pipelines and structures required to be watertight.
 - 1. Test gravity sewers and drain lines by infiltration/exfiltration testing.
 - 2. Test all other pipelines with water under the specified pressures.
- B. Operation of Existing Facilities: Conduct all tests in a manner to minimize as much as possible any interference with the day-to-day operations of existing facilities or other contractors working on the site.

1.2 PERFORMANCE REQUIREMENTS

- A. Written Notification of Testing: Provide written notice when the work is ready for testing, and make the tests as soon thereafter as possible.
 - 1. Personnel for reading meters, gauges, or other measuring devices, will be furnished.
 - 2. Furnish all other labor, equipment, air, water and materials, including meters, gauges, smoke producers, blower, pumps, compressors, fuel, water, bulkheads and accessory equipment.

1.3 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. AWWA C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

1.4 SUBMITTALS

- A. General: Provide all submittals, including the following, as specified in Division 1.
- B. Testing Report: Prior to placing the sewer system in service submit for review and approval a detailed report summarizing the leakage test data, describing the test procedure and showing the calculations on which the leakage test data is based.
 - 1. Reference Sewer Line Data

a. For Low Pressure Testing

- (1) The length and diameter of the section of line tested (MH to MH), including any laterals.
- (2) A complete description of the test procedure, including:
 - (a) Trench backfilling and sewer cleaning status
 - (b) Type of plugs used and where
 - (c) Depth of sewer, and ground water pressure over sewer pipe
 - (d) Stabilization time period and air pressure
 - (e) Actual air test pressures used if ground water is present
 - (f) The time allowed by specifications
 - (g) The actual test time
 - (h) The air pressure at beginning and end of test
- (3) The name of the inspector/tester and the date(s) and time(s) of all testing performed, including any retesting.
- (4) A description of any repairs made.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 LEAKAGE TESTING

- A. All new sewer and water pipelines installed shall be tested for leakage. The test used will be Hydrostatic Testing for pressure lines and Infiltration/Exfiltration Testing for gravity lines. Tests to be performed will be indicated by the ENGINEER and witnessed by the ENGINEER and the County Manager or designee.

1. Flushing

- a. Full-bore flush all mains to remove all sand and other foreign matter. Flushing shall be terminated at the direction of the ENGINEER. Dispose of the flushing water without causing nuisance or property damage. Full bore flushes on force mains shall only be required where sufficiently sized water mains are present.
- b. Install temporary flush out connections on all dead end water mains at the locations shown on plans and in accordance with the Collier County Standard Details.

2. Hydrostatic Testing for DIP and PVC Pipelines:

Perform hydrostatic testing of the system as set forth in the following, and conduct said tests in the presence of the County Manager or designee and other authorized agencies, with 48 hours advance notice provided.

Piping and appurtenances to be tested shall be within sections between valves unless alternate methods have received prior approval from the County Manager or designee. Testing shall not proceed until concrete thrust blocks are in place and cured, or other restraining devices installed. Thoroughly clean and flush all piping prior to testing to clear the lines of all foreign matter. While the piping is being filled with water care shall be exercised to permit the escape of air from extremities of the test section, with additional release cocks provided if required.

Perform hydrostatic testing with a sustained minimum pressure of 150 psi for a period of not less than two (2) hours. If sustained pressure goes 5 psi above or below 150 psi during the first two (2) hours, the test fails (AWWA regulation). After two (2) hours, use the AWWA formula if less than 5 psi to determine whether test fails. Testing shall be in accordance with the applicable provisions as set forth in the most recent edition of AWWA Standards C600 for Ductile Iron Pipe and C605 for PVC Pipe. The allowable rate of leakage shall be less than the number of gallons per hour determined by the following formula:

$$L = \frac{SD (P)^{1/2}}{133,200}$$

Where,

L = Allowable leakage in gallons per hour;
 S = Length of pipe tested in feet;
 D = Nominal diameter of pipe in inches;
 P = Average test pressure maintained during the leakage test in pounds per square inch

For 150 psi, $L = (9.195 \times 10^{-5}) SD$

The testing procedure shall include the continued application of the specified pressure to the test system, for the one-hour period, by way of a pump taking supply from a container suitable for measuring water loss. The amount of loss shall be determined by measuring the volume displaced for the said container.

Should the test fail, repair the fault and repeat the test until results are within the established limits. Furnish the necessary labor, water, pumps, and gauges at specified location(s) and all other items required to conduct the required testing and perform necessary repairs.

General - All sanitary sewers and associated service lines shall be constructed watertight to prevent infiltration and/or exfiltration.

3. Hydrostatic Testing for HDPE Pipelines:

Perform hydrostatic testing of all HDPE pipelines as set forth in the following, and conduct said tests in the presence of the County Manager or designee and other authorized agencies, with 48 hours advance notice provided.

Provide all labor, equipment and material required for testing the pipeline upon completion of installation, pipe laying and backfilling operations, and placement of any required temporary roadway surfacing.

Disinfect all HDPE potable water mains prior to testing in accordance with the requirements of Section 025400 – Disinfection.

Test pipelines at 150 psi.

Field test all HDPE pipelines for leakage in accordance with manufacturer's recommendations for the size and class of pipeline installed. Unless other procedures recommended by the manufacturer are approved by the County Manager or designee, pressure test the pipeline as follows:

- a. Fill pipeline slowly with water. Maintain flow velocity less than two (2) feet per second.
- b. Expel air completely from the line during filling and again before applying test pressure. Expel air by means of taps at points of highest elevation.
- c. Apply initial test pressure and allow to stand without makeup pressure for two (2) to three (3) hours, to allow for diametric expansion or pipe stretching to stabilize.

- d. After this equilibrium period, apply the specified test pressure and turn the pump off. The final test pressure shall be held for not less than two (2) hours.
- e. Upon completion of the test, the pressure shall be bled off from the location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the County Manager or designee at the point where the pressure is being monitored.

Allowable amount of makeup water for expansion of the pipeline during the pressure test shall conform to Table III, Test Phase Make-up Amount, contained in the manual "Inspections, Test and Safety Considerations" published by the Plastics Pipe Institute, Inc.

If any test of pipeline installed exceeds the amount of makeup water as allowed above, locate and repair the cause of leakage and retest the pipeline, without additional cost to the COUNTY. Repair all visible leaks regardless of the amount of leakage.

- 4. Force Main Pressure Testing: All force mains shall be subject to pressure testing at 150 PSI.

Allowable leakage on force mains shall be computed utilizing the standards for water loss in conformance with AWWA C600, the latest revision thereof.

- 5. Infiltration/Exfiltration Testing for Gravity Lines

The allowable limits of infiltration or exfiltration for the entire system, or any portion thereof, shall not exceed a rate of 50 gallons per inch of inside pipe diameter per mile of pipe per 24 hours. No additional allowance shall be made for house service lines. Any part of or all of the system shall be tested for infiltration or exfiltration, as directed by the ENGINEER or as required by the County Manager or designee. The procedures and limitations for conducting infiltration/exfiltration tests shall be established at the pre-construction conference on a project-by-project basis. Air testing of gravity sewer mains may be required. All testing shall be run continuously for 24 hours, unless the County Inspector can visually verify that this test duration is not required due to the observed infiltration/exfiltration rate. The amounts of infiltration or exfiltration shall be determined by pumping water into or out of calibrated drums, or by other methods approved by the Public Utilities Division, such as in-line V-notch weirs. Where infiltration or exfiltration exceeds the allowable limits specified herein, locate and repair the defective pipe, joints or other faulty construction at no additional cost to the COUNTY. If the defective portions cannot be located, remove and reconstruct as much of the work as is necessary in order to conform to the specified allowable limits. All visible leaks shall be repaired regardless of the amount of leakage. Provide all labor, equipment and materials required and conduct all testing required under the direction of the ENGINEER.

- a. Infiltration: Prior to testing for infiltration, the system shall be pumped out so that normal infiltration conditions exist at the time of testing. The cumulative results of the entire collection system results shall not be a satisfactory method for gauging infiltration compliance. Each sewer section between manholes must permit infiltration no greater than the maximum allowable, as specified above.
- b. Exfiltration: The exfiltration test, when required due to groundwater levels, will be conducted by filling the portion of the system being tested with water to a level 2 feet above the uppermost manhole invert in the section being tested. The cumulative results of the entire collection system results shall not be a satisfactory method for gauging exfiltration compliance. Each sewer section between manholes must permit exfiltration no greater than the maximum allowable, as specified above.

6. Low Pressure Air Testing

Contractor shall conduct air testing in accordance with ASTM specifications:

- a. ASTM C-828 – for clay pipes.
- b. ASTM C-924 – for concrete pipes.
- c. ASTM F-1417 – for plastic pipes.

When low pressure air testing of gravity sewer mains is specifically required, all testing shall be run continuously for 24 hours, unless the County Inspector can visually verify that this test duration is not required due to the observed infiltration/exfiltration rate.

When air testing is specifically required, after completing backfill of a section of gravity sewer line, conduct a Line Acceptance Test using low pressure air. The test shall be performed using the below stated equipment, according to state procedures and under the supervision of the ENGINEER and in the presence of the County Manager or designee, with 48 hours advanced notice.

- d. Equipment:
 - (1) Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.
 - (2) Pneumatic plugs shall resist internal bracing or blocking.
 - (3) All air used shall pass through a single control panel.

(4) Three individual hoses shall be used for the following connections:

- (a) From control panel to pneumatic plugs for inflation.
- (b) From control panel to sealed line for introducing the low-pressure air.
- (c) From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

e. Procedure:

All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psi. The sealed pipe shall be pressurized to 5 psi. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

After a manhole-to-manhole reach of pipe has been backfilled and cleaned and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psi. Low-pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psi greater than the average back pressure of any ground water that may be over the pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize. After the stabilization period (3.5 psi minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of the line being tested shall be termed "Acceptable", if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psi (greater than the average back pressure of any ground water that may be over the pipe) is greater than the time shown for the given diameters in the following table:

<u>Pipe Diameter</u> <u>In Inches</u>	<u>Minutes</u>
8	4.0
10	5.0
12	5.5
16	7.5
18	8.5
24	11.5

Time in Minutes = 0.472 D
D = Diameter of pipe in inches

In areas where ground water is known to exist, install capped pipe adjacent to the top of the sewer lines. This shall be done at the time of the sewer line is installed. Immediately prior to the performance of the Line Acceptance Test, the ground water shall be determined by removing the pipe cap, and a measurement of the height in feet of water over the invert of the pipe shall be taken. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings. (For example, if the height of water is 11-1/2 feet, then the added pressure will be 5 psi. This increases the 3.5 psi to 8.5 psi, and the 2.5 psi to 7.5 psi. The allowable drop of one pound and the timing remain the same).

If the installation fails to meet this requirement, determine the source of the leakage and repair or replace all defective materials and/or workmanship, all at no additional cost to the COUNTY.

- B. DEP approval is required to use reclaimed (IQ) water for flushing and pressure testing of irrigation mains and potable water mains. The requirements for submitting a request to DEP are available from the County PUED.

3.2 LEAKAGE TESTS FOR STRUCTURES

- A. Structure Leakage Testing: Perform leakage tests of manholes, wet wells, tanks, vaults and similar purpose structures before backfilling, by filling the structure with water to the overflow water level and observing the water surface level for the following 24 hours.
 1. Make an inspection for leakage of the exterior surface of the structure, especially in areas around construction joints.
 2. If visible leaks appear, repair the structure by removing and replacing the leaking portions of the structure, waterproofing the inside, or by other methods approved.

3. Water for testing will be provided by the COUNTY at the CONTRACTOR's expense.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 024100

DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: All work necessary for the removal and disposal of structures, foundations, piping, equipment and roadways, or any part thereof including masonry, steel, reinforced concrete, plain concrete, electrical facilities, and any other material or equipment shown or specified to be removed.
- B. Basic Procedures and Schedule: Carry out demolition so that adjacent structures, which are to remain, are not endangered. Schedule the work so as not to interfere with the day-to-day operation of the existing facilities. Do not block doorways or passageways in existing facilities.
- C. Additional Requirements: Provide dust control and make provisions for safety.
- D. Related Work Specified in Other Sections Includes:
 - 1. Section 017416 – Site Clearing
 - 2. Section 020500 – Connection to Existing Systems

1.2 SUBMITTALS

- A. Provide all submittals, including the following, as specified in Division 1.
- B. Site Inspection: Visit the site and inspect all existing structures. Observe and record any defects that may exist in buildings or structures adjacent to but not directly affected by the demolition work. Provide the County Manager or designee with a copy of this inspection record and obtain the ENGINEER's and the County's Manager or designee approval prior to commencing the demolition.

1.3 QUALITY ASSURANCE

- A. Limits: Exercise care to break concrete well for removal in reasonably small masses. Where only parts of a structure are to be removed, cut the concrete along limiting lines with a suitable saw so that damage to the remaining structure is held to a minimum.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION OF EXISTING DRAWINGS

- A. Available drawings of existing structures and equipment will be available for inspection at the office of the ENGINEER.

3.2 PROTECTION

- A. General Safety: Provide warning signs, protective barriers, and warning lights as necessary adjacent to the work as approved or required. Maintain these items during the demolition period.
- B. Existing Services: Undertake no demolition work until all mechanical and electrical services affected by the work have been properly disconnected. Cap, reroute or reconnect interconnecting piping or electrical services that are to remain in service either permanently or temporarily in a manner that will not interfere with the operation of the remaining facilities.
- C. Hazards: Perform testing and air purging where the presence of hazardous chemicals, gases, flammable materials or other dangerous substances is apparent or suspected, and eliminate the hazard before demolition is started.

3.3 DEMOLITION REQUIREMENTS

- A. Explosives: The use of explosives will not be permitted.
- B. Protection: Carefully protect all mechanical and electrical equipment against dust and debris.
- C. Removal: Remove all debris from the structures during demolition and do not allow debris to accumulate in piles.
- D. Abandoned Pipelines: Fill all abandoned pipelines using grout in accordance with Section 033100.
- E. Access: Provide safe access to and egress from all working areas at all times with adequate protection from falling material.
- F. Protection: Provide adequate scaffolding, shoring, bracing railings, toe boards and protective covering during demolition to protect personnel and equipment against injury or damage. Cover floor openings not used for material drops with material substantial enough to support any loads placed on it. Properly secure the covers to prevent accidental movement.
- G. Lighting: Provide adequate lighting at all times during demolition.

- H. Closed Areas: Close areas below demolition work to anyone while removal is in progress.
- I. Material Drops: Do not drop any material to any point lying outside the exterior walls of the structure unless the area is effectively protected.
- J. Chemicals: All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with manufacturer's instructions or government regulations as applicable.

3.4 ASBESTOS-CONCRETE (AC) PIPE

- A. If existing asbestos-cement pipe is encountered during the course of construction, remove the AC pipe and replace it with C900 PVC pipe having a pressure rating as required elsewhere in these specifications. Replace the AC pipe with PVC pipe for a distance of 10 feet each way from the centerline of the pipe under construction or 5 feet beyond the length of AC pipe exposed by trench excavation, whichever is greater. A change order will be issued for required replacement of AC pipe not shown on the drawings.
- B. Coordinate the shutdown of the AC pipeline with the County Manager or designee in accordance with Section 020500, including proper notice to the County Manager or designee and any customers that may be affected by the shutdown as required by these specifications and/or current Water Department policy. In the event of an unanticipated encounter with AC pipe, immediately recover and protect the pipe and notify the COUNTY Water Department.
- C. Perform cutting of AC pipe by means of cutting wheels mounted in a chain wrapped around the pipe barrel. Do not use power driven saws with abrasive discs or any other means that produce concentrations of airborne asbestos dust.

3.5 DISPOSAL OF MATERIALS

- A. Final Removal: Dispose of AC pipe in accordance with COUNTY special handling requirements and coordination with Collier County Solid Waste Management Department. Remove all other debris, rubbish, scrap pieces, equipment, and materials resulting from the demolition. Take title to all demolished materials and remove such items from the site.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 025400

DISINFECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Disinfection of all pipelines, tanks, structures, conduits and equipment that are to store, handle or carry potable water. Furnish all labor, water, chemicals and equipment, including taps, corporation stops, temporary pumps and other items necessary to perform the Work, except as otherwise specified.

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. AWWA C651 - Disinfecting Water Mains
 - 2. AWWA C652 - Disinfection of Water-Storage Facilities

1.3 QUALITY ASSURANCE

- A. Disinfection Standards: Disinfect in accordance with AWWA C651 for water mains and AWWA C652 for water storage facilities and equipment.
- B. Chlorinated Water Disposal: Dispose of old highly chlorinated water in accordance with applicable regulations.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 FLUSHING

- A. After coordination with the COUNTY Water Distribution Section, perform all flushes, pigging or swabbing, disinfection and post flushes in the presence of Water department personnel. Fill all water lines with potable water, pig or swab and perform a line flushing. All lines larger than 12 inches in diameter shall be pigged to clear debris prior to flushing. Use a swab-type pig for HDPE pipe. Use a 5- to 7-lb. density poly-jacketed bullet style pig for all other pipe material. Under no circumstances is a pig or swab considered reusable. A section of pipe shall be

inserted in the gap specified in the jumper shown in the Standard Details to connect the new construction to the existing facilities for the purpose of accomplishing the full-bore flush. Immediately after completion of the flush, remove the connection. The facilities shall be capped and returned to the jumper connection shown in the Standard Details until final connection is permitted by County Manager or designee at the completion of construction and after finalization of all test procedures and bacterial clearance for new water facilities.

3.2 WATER MAIN DISINFECTION

- A. Following acceptable pressure testing, disinfect all sections of the water distribution system and receive approval thereof from the appropriate agencies, prior to placing in service. Provide advance notice of 48 hours to the County Manager or designee before disinfecting procedures start. The disinfection shall be accomplished in accordance with the applicable provisions of AWWA Standard C651, "Disinfecting Water Mains" and all appropriate approval agencies.
- B. The disinfecting agent shall be free chlorine in aqueous solution with sustained concentration for 48 hours of not less than 50 parts per million. After 48 hours, if chlorine solution contains at least 25 parts per million of chlorine, the line may then be flushed and samples taken at various points. Chlorine may be derived from Chlorine gas, or 70% (high test) calcium hypochlorite (HTH or Perchloron, or equal). Administration may be by any of the several methods described in AWWA Standard C651 as proposed by the CONTRACTOR and approved by the ENGINEER. Proposals as to method must be made prior to commencement of the disinfection process.
- C. Following contact with chlorine solution, the system shall be thoroughly flushed out. Schedule water sampling in coordination with the COUNTY Water Distribution Section. The COUNTY Water Department will obtain all water samples for analysis.
- D. If samples do not demonstrate satisfactory results, the line shall be flushed and a resample taken. If the samples fail on the second attempt, redisinfection per AWWA standards must be repeated until two satisfactory samples are obtained. The period between samples must be a minimum of 24 hours.
- E. After approval of the samples, and before placing the system in service, perform another flushing of the water lines to remove any stagnant water.

3.3 WATER MAIN DISINFECTION (FOR FIRE LINE CONNECTIONS WITH NO TEMPORARY JUMPER)

- A. In configurations where 20 feet or less of new pipe is installed between the existing COUNTY water main and the permanent above ground fire assembly, the temporary gap configuration assembly may be omitted if the following requirements are met:

1. The full interior of all new pipe between the existing COUNTY water main and the permanent above ground fire assembly shall be swabbed and disinfected using a chlorine solution with a concentration of not less than 200 parts per million.
2. The pipe must be flushed and bacteriological samples must be collected in accordance with this specification.
3. The tapping valve on the COUNTY water main shall remain closed until bacteriological clearance is achieved.

3.4 DISINFECTION PROCEDURES FOR TANKS

- A. Disinfect potable water storage tanks and equipment in accordance with AWWA C652, Method 2 or 3, using sodium hypochlorite.
 1. In Method 2, spray method, spray the entire interior surface of the tank with chlorinated water containing 200 mg/l of available chlorine. After spraying, allow the tank to stand at least two hours before filling with fresh water.
- B. After disinfection, allow the tanks and equipment to overflow until the chlorine residual is approximately 2 mg/l.

3.5 BACTERIAL SAMPLE POINTS

- A. For the purpose of new water main construction, bacterial sampling points shall be positioned at the beginning of each new system, at 1000-foot intervals and all dead ends unless otherwise directed. These sampling points will be utilized by Utilities personnel for water main bacterial clearance procedures. At the completion of the project, when authorization is given by the County Manager or designee, permanent sampling points shall remain every 3000 feet or one at 2/3 of the length from the point of connection to the COUNTY system if the line is less than 3000 feet long. All others shall be removed down to the main and properly capped by the CONTRACTOR. The permanent sampling points shall be constructed as shown in the Utility Detail Drawings. Collier County staff will review the permanent sampling point locations during final plans review.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 031100
CONCRETE FORMWORK

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Provide concrete formwork for architectural concrete and structural concrete as specified to form concrete to profiles shown.
 - 1. Provide concrete with smooth rubbed finish.
 - 2. Structural concrete is defined as all concrete that is not architectural concrete.
- B. Related Work Specified in Other Sections Includes:
 - 1. Section 03200 - Concrete Reinforcement

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. ACI 318 - Building Code Requirements for Reinforced Concrete
 - 2. ACI SP-4 - Formwork for Concrete

1.3 SUBMITTALS

- A. Provide all submittals, including the following, as specified in Division 1.
 - 1. CONTRACTORS Shop Drawings: Proposed form layout drawings and tie pattern layout drawings for Concrete. Review of these drawings does not relieve the CONTRACTOR of responsibility for adequately designing and constructing forms.
 - 2. Samples: Pieces of each type of sheeting, chamfer strips, form ties, form liners and rustication strips

1.4 QUALITY ASSURANCE

- A. Formwork Compliance: Use formwork complying with ACI SP-4, ACI 347 and ACI 303R.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. For acceptable manufacturers of concrete release agent, concrete form coating, concrete form liners, or concrete rustications see County Approved Product List, Appendix F.

2.2 MATERIALS

- A. Structural Concrete: Provide structural concrete form materials as follows:
 - 1. Obtain approval for form material before construction of the forms.
 - 2. Use a barrier type form release agent.
 - 3. Use form ties, hangers, and clamps of such type that, after removal of the forms, no metal will be closer than one inch from concrete surface. Wire ties will not be permitted.
 - 4. Provide ties with swaged washers or other suitable devices to prevent seepage of moisture along the ties. Leave the ties in place.
 - 5. Use lugs, cones, washers, or other devices that do not leave holes or depressions greater than 7/8-inch in diameter.

PART 3 EXECUTION

3.1 DESIGN

- A. Design Responsibility: Be responsible for the design, engineering and construction of the architectural concrete formwork and the structural concrete formwork. Conform the work to the recommendations of ACI SP-4 and ACI 303R.
- B. Setting Time and Slag Use: The presence of fly ash or ground granulated blast furnace slag in the concrete mix for architectural concrete and structural concrete will delay the setting time. Take this into consideration in the design and removal of the forms.
- C. Responsibility During Placement: Assume and take sole responsibility for adequate design of all form elements for support of the wet concrete mixtures specified and delivered.
- D. Consistency: Design forms to produce concrete members identical in shape, lines and dimensions to members shown.

3.2 CONSTRUCTION DETAILS FOR FORMWORK

A. Structural Concrete Details: Follow the following details for all structural concrete:

1. Provide forms that are substantial, properly braced, and tied together to maintain position and shape and to resist all pressures to which they may be subjected. Make forms sufficiently tight to prevent leakage of concrete.
2. Determine the size and spacing of studs and wales by the nature of the work and the height to which concrete is placed. Make forms adequate to produce true, smooth surfaces with not more than 1/8-inch variation in either direction from a geometrical plane. Provide horizontal joints that are level, and vertical joints, which are plumb.
3. Supply forms for repeated use in sufficient number to ensure the required rate of progress.
4. Thoroughly clean all forms before reuse and inspect forms immediately before concrete is placed. Remove deformed, broken, or defective forms from the work.
5. Provide temporary openings in forms at convenient locations to facilitate cleaning and inspection.
6. Coat the entire inside surfaces of forms with a suitable form release agent just prior to placing concrete. Form release agent is not permitted on the reinforcing steel.
7. Assume and take responsibility for the adequacy of all forms and remedying any defects resulting from their use.

3.3 FORM REMOVAL

- #### A. Structural Concrete Form Removal: Do not remove forms for structural concrete until the concrete has hardened sufficiently to support its own load safely, plus any superimposed load that might be placed thereon.

3.4 TOLERANCES

- #### A. Tolerance Limits: Design, construct and maintain concrete form and place the concrete to provide completed concrete work within the tolerance limits set forth in ACI SP-4.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 032000
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for providing concrete reinforcement as shown and specified herein. Reinforcement includes all steel bars, wire and welded wire fabric as shown and specified.
- B. Related Work Specified in Other Sections Includes:
 - 1. Section 031100 - Concrete Formwork
 - 2. Section 034100 - Precast Concrete Structures

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. ACI SP66 - ACI Detailing Manual
 - 2. ACI 318 - Latest edition "Building Code Requirements for Reinforced Concrete"
 - 3. ASTM A 185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 4. ASTM A 615/A615M - Deformed and Plains Billet-Steel Bars for Concrete
 - 5. ASTM A 706/A706M - Low Alloy Steel Deformed Bars for Concrete Reinforcement
 - 6. ASTM A 775/A775M - Epoxy Coated Reinforcing Steel Bars
 - 7. AWS D1.4 - Structural Welding Code - Reinforcing Steel

1.3 SUBMITTALS

- A. Provide all submittals, including the following, as specified in Division 1.
 - 1. Product Data and Information: Submit manufacturers literature with product data, and material description of fusion bonded epoxy coating for reinforcement and reinforcement accessories, including manufacturer's

recommendations for field touch-up of mars and cut ends when epoxy coated reinforcement is specified to be used.

2. CONTRACTORS' Shop Drawings: Submit checked Working Drawings, including bar lists, schedules, bending details, placing details and placing plans and elevations for fabrication and placing reinforcing steel conforming to "ACI Detailing Manual SP-66".
 - a. Do not bill wall and slab reinforcing in sections. Show complete elevations of all walls and complete plans of all slabs, except that, when more than one wall or slab are identical, only one such elevation or plan is required. These plans and elevations need not be true views of the walls or slabs shown. Bill every reinforcing bar in a slab on a plan. Bill every reinforcing bar in a wall on an elevation. Take sections to clarify the arrangement of the steel reinforcement. Identify all bars, but do not bill on such sections.
 - b. For all reinforcing bars, unless the location of a bar is clear, give the location of such bar or bars by a dimension to some structural feature that will be readily distinguishable at the time bars are placed.
 - c. Make the reinforcing steel placing drawings complete for placing reinforcement including the location of support bars and chairs, without reference to the design drawings.
 - d. Submit Detailer certification that every reinforcing steel placing drawing and bar list is completely checked and corrected before submittal for approval.
 - e. If, after reinforcing steel placing drawings and bar lists have been submitted for approval, a review reveals that the drawings and lists obviously have not been checked and corrected they will be returned for checking and correcting by the Detailer.
3. Samples: Submit the following samples when epoxy coated reinforcement is specified to be used.
 - a. 12-inch long epoxy-coated steel reinforcing bar, of any size typical to this Project
 - b. One of each type of epoxy-coated reinforcement accessory used on this Project
 - c. 12-inch long, nylon coated tie wire
4. Certificates: Test certificates of the chemical and physical properties covering each shipment of reinforcing steel bars. Test for bars 3/4 inches in diameter and larger shall consist of the bar being bent cold to 90 degrees

around a pin 3 times the diameter of the test bar without evidence of cracking.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle all products and materials as specified in Division 1 (and as follows:)
 - 1. Delivery Requirements: Have reinforcing steel delivered to the work in strongly tied bundles. Identify each group of both bent and straight bars with a metal tag giving the identifying number corresponding to the reinforcing steel placing drawings and bar lists.
 - 2. Storage: Properly store all bars in an orderly manner, with all bars completely off the ground. Keep bars clean after delivery to the site of the work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The brand of manufacturer shall be legibly rolled on all bars, and when loaded for mill shipment, all bars shall be properly separated and tagged with manufacturer's test identification number.
- B. For acceptable manufacturers of mechanical connections see County Approved Product List, Appendix F.

2.2 MATERIALS

- A. Steel Bars: Use new billet steel bars, deformed bars, meeting the requirements of ASTM A615/A625M Grade 60 for reinforcing steel bars.
 - 1. Roll all reinforcing steel bars with special deformations or identifying marks indicating the ASTM Specification and Grade.
 - 2. Use bars free from defects, kinks and from bends that cannot be readily and fully straightened in the field.
 - 3. Supply reinforcing bars in lengths that will allow convenient placement in the work and provide the required length of at least 40 diameters of lap of joints as shown. Provide dowels of proper length, size and shape for tying walls, beams, floors, and the like together.
- B. Epoxy Coating: Conform fusion bonded epoxy coated reinforcing steel bars to ASTM A775/A775M when used. Leave portions of the reinforcing steel bars uncoated where mechanical connections are shown.

- C. Welded Wire Fabric: Use welded wire fabric of the electrically welded type, with wires arranged in rectangular patterns, of the sizes shown or specified and meeting the requirements of ASTM A185.
- D. Supports and Accessories: Provide bar supports and other accessories and, if necessary, additional supports to hold bars in proper position while concrete is being placed.
 - 1. Use side form spacers against vertical or sloping forms to maintain prescribed side cover and cross position of bars.
 - 2. Use individual hi-chairs with welded cross ties or circular hoops to support top bars in slabs thicker than 8 inches.
 - 3. Bolsters, chairs and other accessories:
 - a. Use hot-dipped galvanized or provide plastic coated legs when in contact with forms for surfaces of concrete other than architectural surfaces.
 - b. Use stainless steel when in contact with forms for architecturally exposed surfaces.
 - c. Use epoxy coated bolsters, chairs and accessories including wire ties for epoxy coated reinforcing bars.
 - d. Use chairs of an approved type and space them properly to support and hold reinforcing bars in position in all beams and slabs including slabs placed directly on the subgrade or work mat. Do not use continuous hi-chairs for supporting of top bars in slabs over 8 inches in thickness.
- E. Mechanical Connections: Provide mechanical connections that develop at least 125 percent of the specified yield strength of the bar in tension.
- F. Stirrups and Ties: Provide stirrups and ties as shown and specified and meeting the requirements of ASTM A185.

2.3 FABRICATION

- A. Drawing Review Prior to Fabrication: Do not fabricate any material before final review and approval of shop drawings.
- B. Bending and Cutting: Cut bars to required length and bend accurately before placing. Bend bars in the shop unless written approval for field bending is obtained. If field bending is permitted, do it only when the air temperature, where

the bending operation is performed, is above 30 degrees F. Do not field bend bars that have been partially embedded in concrete.

- C. Splices: Use lapped splices for tension and compression splices unless otherwise noted.
- D. Cleaning: Clean and bend reinforcement in accordance with ACI 315 and ACI 318.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Placement: Place all bars in accordance with CRSI "Recommended Practice for Placing Reinforcing Bars".
- B. Tolerances: Place bars used for top reinforcement in slabs to a vertical tolerance of plus or minus 1/4-inch. Place all other reinforcement to the tolerances given to ACI 318.
- C. Cleaning: Have reinforcing steel delivered without rust other than that accumulated during transportation to the work. At all times, fully protect reinforcing steel from moisture, grease, dirt, mortar and concrete. Before being placed in position, thoroughly clean reinforcing steel of all loose mill scale and rust and of any dirt, oil, grease coatings, or other material that might reduce the bond. If there is a delay in depositing concrete, inspect and satisfactorily clean the steel immediately before the concrete is placed.
- D. Bar Positioning: Place bars in the exact positions shown with the required spacing and cross wire bars securely in position at intersections to prevent displacement during the placing of the concrete. Fasten the bars with annealed wire of not less than 17 gauge or other approved devices.
- E. Bar Extension Beyond Formwork: On any section of the work where horizontal bars extend beyond the length of the forms, perforate the form or head against which the work ends or at the proper places to allow the bars to project through a distance at least equal to the lap specified.
- F. Unacceptable Materials: Do not place reinforcing steel with damaged, unsuitably bonded epoxy coating or rusting. If approved, bars, exposed threads of mechanical connections and cut ends may be field coated with approved epoxy coating material.
- G. Review of Placement: Have reinforcing placement reviewed by the ENGINEER before concrete is placed.

- H. Welding - Not Approved: Do not use reinforcing bar assemblies made by welding of any kind, or accessories of any kind which require field welding to reinforcing bars.
- I. Welding - Approved: Where welding of reinforcing steel is shown, AWS D1.4 "Structural Welding Code - Reinforcing Steel" applies.
- J. Tension and Compression Lap Splices: Conform tension and compression lap splices to ACI 318 with all supplements. Avoid splices at points of maximum tensile stress wherever possible. Provide temperature bars with the clear spacing shown. Stagger all bar splices in hoop tension bars in circular tanks with not more than 50 percent of the bars spliced in any one direction. Have welded splices made by certified welders in accordance with AWS D1.4.
- K. Welded Wire Fabric: Place welded wire fabric in the positions shown, specified or required to fit the work. Furnish and place suitable spacing chairs or supports, as specified for bars, to maintain the fabric in the correct location. Where a flat surface of fabric is required, provide flat sheets, when available. Otherwise reverse roll the fabric or straighten to make a perfectly flat surface before placing. Obtain approval for the length of laps not indicated.
- L. Concrete Cover: Place reinforcing steel and welded wire fabric and hold in position so that the concrete cover, as measured from the surface of the bar or wire to the surface of the concrete, is as shown or specified.

END OF SECTION

SECTION 033100
CONCRETE, MASONRY MORTAR AND GROUT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Cement, sand, aggregate admixtures and water for use in concrete, masonry mortar and grout.

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
1. ASTM C 91 – Masonry Cement
 2. ASTM C 144 – Aggregate for Masonry Mortar
 3. ASTM C 150 – Portland Cement
 4. ASTM C 207 – Hydrated Lime for Masonry Purposes
 5. ASTM C 270 – Mortar for Unit Masonry
 6. ASTM C 231 – Air Content of Freshly Mixed Concrete
 7. ASTM C 404 – Aggregate for Masonry Grout
 8. ASTM C 476 – Grout for Masonry
 9. ASTM C 780 – Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
 10. ASTM C 1019 – Sampling and Testing Grout
 11. CRD C-619 – Specification for Grout Fluidifier.
 12. CRD C-621 – Specification for Non-Shrink Grout.
 13. Brick Institute of America Research Report No. 15
 14. ACI 530.1/ASCE 6-92 – Specifications for Masonry Structures

1.3 SUBMITTALS

- A. Provide all submittals, including the following, as specified in Division 1.

B. Product Data and Information: Submit the following:

1. Furnish notarized certificates of manufacture as evidence that the cement conforms to the specified requirements. Include mill-test reports on the cement.
2. Furnish notarized certificates to verify that the hydrated lime and aggregates meet the specified requirements.
3. Furnish laboratory tests as evidence that the air content and masonry mortar compressive strength meet the requirements of ASTM 270 Type N and that the efflorescence tendency meets the requirements of the wick test in Brick Institute of America Research Report No. 15.
4. Furnish laboratory tests as evidence that the masonry grout compressive strength is equal to or greater than 2,500 psi at 28 days.

1.4 DELIVERY, STORAGE AND HANDLING

- A. General: Deliver, store and handle all mortar and grout materials as recommended by the manufacturers and as specified in Division 1 (and as follows:)
- B. Cement: Store cement in weathertight buildings that will exclude moisture and contaminants. Do not use cement that has deteriorated from storage.
- C. Hydrated Lime: Store hydrated lime in weathertight buildings which will exclude moisture and contaminants.
- D. Aggregates: Keep aggregates clean and free from all other materials during transportation and handling. Stockpile aggregate in a manner to prevent segregation.

PART 2 PRODUCTS

2.1 CEMENT

- A. Portland Cement shall be of a standard brand and shall conform to the requirements of ASTM C150-latest edition, except as hereinafter stated. One bag of cement shall be considered as weighing 94 pounds. Type I shall be used unless higher cement is specified, in which event Type III shall be used. For Type I, the maximum amount of tricalcium silicate shall be 60 percent. Cement may be shipped either in paper or cloth sacks and the package shall have the brand and name of manufacturer plainly marked on the outside. All cement shall be stored in weatherproof buildings in such a manner as will prevent absorption of moisture by the lower layers. Shipment shall be segregated by lot for identification. Type I

cement which has been in storage more than 90 days shall be re-tested before use. Where carload shipments are used, a certificate from an approved testing laboratory shall be submitted prior to use of such cement on the job.

2.2 AGGREGATE

A. Fine Aggregate:

1. Composition: Fine aggregate shall consist of natural sand and shall be graded from coarse to fine within the following limits shown in the table below. Sand failing to meet the minimum requirement for material passing the Number 50 and/or Number 100 Sieve may be used, provided other satisfactory inorganic fine materials are added. If two sands are used, each must be mixed, after separate weighing, in proportions approved by the County Manager or designee.

U.S. Standard Square Opening Sieve	Percent of Total By Weight Passing	
	Minimum	Maximum
No. 4	97	100
No. 8	80	100
No. 30	25	75
No. 50	10	30
No. 100	2	10
No. 200 (By Washing)	0	4

2. Stockpiling: Fine aggregate shall be stored on a well-drained site, which has been cleared, grubbed and cleaned. Stockpiles shall be built up so as to prevent segregation of large and small particles.
3. Unsuitable Materials in Fine Aggregate: Not more than one percent (1%) by weight of clay lumps or soft, disintegrated or coated grains shall be present in the fine aggregate. It shall also be free from foreign material such as dirt, wood, paper, burlap, or other unsuitable material. When tested in accordance with AASHTO T-21-27, it shall show a color not darker than standard. When tested for mortar strength in accordance with AASHTO T-71-38, the fine aggregate shall have a tensile strength at three (3) days (Type III), or at seven (7) days, (Type I); not less than 95 percent of that developed by mortar having the same water-cement ratio and consistency, made of the same cement and graded Ottawa Sand having a fineness modulus of 2.40, plus or minus 0.05.

B. Coarse Aggregate:

1. Composition: Coarse aggregate shall consist of crushed stone. It shall be washed to remove clay, loam and dust. At his/her discretion, the County Manager or designee may waive the washing requirement for stone having a loss of not more than 30 percent when tested in accordance with the provisions of AASHTO T-96-38.
2. Unsuitable Material in Coarse Aggregate: The coarse aggregate shall not contain more than the following percentages of deleterious material:

Soft Fibrous, Disintegrated Particles (Weight)	3.0%
Clay Lump (Weight)	0.2%
Finer Than No. 200 Sieve (Weight)	0.5%
Flat or Elongated Particles (Count)	10.0%

When subjected to AASHTO Test T-96-38, the aggregate shall have a loss not greater than 65 percent. Aggregate shall be free from loam, wood, leaves, or other foreign material.

3. Gradation: For unreinforced foundations, for paving or for other unreinforced mass concrete, the gradation of coarse aggregate shall be as shown in Table 1. For reinforced footings, reinforced walls over 6" in thickness, ordinary floor slabs and similar structures, the gradation shall be as shown on Table 2. For handrails, reinforced walls, thin reinforced floor slabs electrical conduit encasement, and similar construction, the gradation shall be as shown on Table 3.

Table 1	
Percent Passing Square Opening Sieve	Percent By Weight
2-1/2 inch	100
2 inch	95 – 100
1 inch	35 – 70
1/2 inch	10 – 30
No. 4	0 – 5
Table 2	
Percent Passing Square Opening Sieve	Percent By Weight
1-1/2 inch	100
1 inch	90 – 100
1/2 inch	25 – 60
No. 4	0 – 10
No. 8	0 – 5

Table 3

Percent Passing Square Opening Sieve	Percent By Weight
1 inch	100
¾ inch	90 – 100
3/8 inch	20 – 55
No. 4	0 – 10
No. 8	0 – 5

4. Stockpiles: Stockpiles shall be constructed in layers not exceeding three feet (3') in height, and material shall be deposited in such manner as to prevent segregation of coarse and fine materials. Each type of aggregate shall be placed in a separate stockpile. Stockpile sites shall be cleared, grubbed and drained before using.

2.3 HYDRATED LIME

- A. Provide hydrated lime meeting the requirements of ASTM C 207.

2.4 WATER

- A. Water shall be clean and free from salt, oil or organic substances. Laboratory tests shall be made to determine suitability of any water for use in concrete unless it is secured from a public water supply.

PART 3 EXECUTION

3.1 CONCRETE PROPORTIONING

- A. Concrete aggregate shall be proportioned by weight. When the sources of supply shall have been determined by the CONTRACTOR and approved by the County Manager or designee, the mix shall be set by an approved testing laboratory. Mix shall be designed for a "slump" suitable for the character of structure in which the concrete is to be incorporated. All concrete shall be as specified herein.
- B. After a suitable design mix has been approved by the County Manager or designee, it shall not be changed so long as materials of the same characteristics are used in the mix. Within the limits of the various cement factors shown above, the mix shall be varied until the homogenous workable mixture, suitable for the class of structure intended, has been obtained.

3.2 CONCRETE MIXING

- A. Concrete mixing shall be by means of a modern batch mixer equipped with accurately operating water measuring device and an automatic time locking device.

- B. Where a central batching plant is not operated, each mixer must have available an approved portable weighing device for use in proportioning. Each batch shall be mixed for one and one-half (1½) minutes after charging has been completed, and during such mixing period, that drum shall operate with a peripheral speed of not less than one-hundred and fifty-three (153), nor more than two-hundred and twenty-five (225) feet per minute. The number of revolutions per minute shall be between fourteen (14) and twenty (20). Retempering concrete or use of concrete in which initial set has taken place will not be allowed. Transit mixed concrete from an approved batching plant and suitable truck mixer may be approved by the County Manager or designee.

3.3 PIPE GROUT

- A. Mix lean grout for backfilling the space surrounding the pipe sections in tunnel or other areas as specified or directed in the proportion of 1 part Portland cement to 12 parts sand by volume.
- B. Mix grout to a consistency that can be pumped into the pipe. Use a grout fluidifier to reduce water quantity and improve workability.

3.4 TESTING

- A. Masonry Mortar: Make and test specimens for preconstruction and construction evaluation of masonry mortar in accordance with the requirements of ASTM C 780.
- B. Masonry Grout: Make and test specimens for preconstruction and construction evaluation of masonry grout in accordance with the requirements of ASTM C 1019.
- C. Concrete shall contain cement, coarse aggregate, and fine aggregate meeting the Specifications contained in previous paragraphs of this Part. Unless otherwise specified or shown in the plans, the design strength of the several elements included in the plans shall be:
 - 1. Four thousand (4,000) pounds minimum compressive strength per square inch at 28 days for all piers, reinforced walls, floors, slabs, precast structures and other special sections where specifically shown on the plans or Standard Details.
 - 2. Two thousand five hundred (2,500) pounds minimum compressive strength per square inch at 28 days for all blocking, reinforced footings, for retaining walls not subject to hydrostatic pressure, or where specifically shown on the plans or shown in the Standard Details.

END OF SECTION

SECTION 034100

PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all materials, labor, and equipment and construct manholes, wet wells, valve pits, meter pits, and accessory items, consisting of precast sections as shown on the Drawings and as specified herein.
- B. The forms, dimensions, concrete, and construction methods shall be approved by the ENGINEER in advance of construction.
- C. These specifications are intended to give a general description of what is required, but do not purport to cover all of the structural design details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, shop testing, delivery, and complete installation of all precast structures whether specifically mentioned in these specifications or not.
- D. The supplier of the precast manholes, wet wells, valve pits, meter pits, and accessory items shall coordinate his work with that of the CONTRACTOR to the end that the unit will be delivered and installed in the excavation provided by the CONTRACTOR, in accordance with the CONTRACTOR's construction schedule.
- E. Coordinate the precast structures fabrication with the equipment supplied to achieve the proper structural top slab openings, spacings, and related dimensions for the selected equipment frames and covers. The top slabs, frames, covers, and subsurface structures shall be capable of supporting a live load of 150 pounds per square foot.

1.2 SUBMITTALS

- A. Submit to the ENGINEER, as provided in the General Conditions, shop drawings showing details of construction, reinforcing and joints.
- B. Shop Drawings
 - 1. Content
 - a. Dimensions and finishes
 - b. Estimated camber

- c. Reinforcing and connection details
 - d. Anchors
 - e. Lifting and erection inserts
 - f. Other items cast into members
- 2. Show location of unit by same identification mark placed on member.
- 3. Include design calculations.
- C. Manufacturer's Literature: Manufacturer's recommended installation instructions.
- D. Manufacturer's certificates of material conformance with specifications.
- E. Test Reports: Reports of tests on concrete.
- F. Testing
 - 1. Manholes and Valve Vaults: Four (4) concrete test cylinders shall be taken for every 50 cubic yards (cu. yds) for each type of precast structure.
 - 2. Pump Stations: Four (4) concrete test cylinders shall be taken for each pump station wet well. Four (4) concrete test cylinders shall be taken for each pump station's top and bottom slabs.
 - 3. Certification: The supplier shall provide the certified results of testing (7 day, 28 day) for the test cylinders stated herein. Random test cylinders may be taken at any time by the ENGINEER at the COUNTY's expense.

1.3 INSPECTION

- A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the ENGINEER, or the County Manager or designee. Such inspection may be made at the place of manufacture, or at the site after delivery, or at both places, and the sections shall be subject to rejection at any time on account of failure to meet any of the Specification requirements; even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the job shall be marked for identification and shall be removed from the job at once. All sections which have been damaged after delivery will be rejected, and if already installed, shall be repaired, if permitted and accepted by ENGINEER, or removed and replaced, entirely at the CONTRACTOR's expense.
- B. At the time of inspection, the sections will be carefully examined for compliance with ASTM C478 designation and these Specifications, and with the approved

manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.

- C. Imperfections may be repaired, subject to the approval of the ENGINEER, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of 7 days and 5,000 psi at the end of 28 days, Epoxy mortar may be utilized for repairs subject to the approval of the ENGINEER.

PART 2 PRODUCTS

2.1 PRECAST CONCRETE WET WELLS AND VALVE VAULTS

- A. Precast submersible pump station wet wells shall consist of precast base, precast wet well sections, and top cover slab. Precast valve vaults shall consist of precast base, sidewalls and top slab. Concrete shall be air entrained at the time of delivery and shall have a minimum compressive strength of 4,000 psi at the end of 28 days.
- B. Joints between precast concrete sections shall be set by plastic shims and fitted with non-metallic non-shrink grout as shown on the drawings.
- C. The top slab sections shall be fitted with watertight hatches. The frames and covers will be sized for the openings shown on the drawings.
- D. The various precast sections should have the inside dimensions and minimum thickness of concrete as indicated on the drawings. All precast and cast-in-place concrete members shall conform to the Building Code Requirements for Reinforced Concrete ACI 318.
- E. A vent pipe shall be furnished and installed as shown on the drawings.
- F. Fillets shall be provided and installed in the wet wells as shown on the drawings.
- G. Precast structures shall be constructed to the dimensions as shown on the drawings and as specified in these Specifications.
- H. Type II cement shall be used except as otherwise approved.
- I. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of each precast section.
- J. Sections shall be cured by an approved method and shall not be shipped until the minimum 7-day compressive strength has been attained.

- K. Each pre-cast section manufactured in accordance with the drawings shall be clearly marked to indicate the intended pump station installation location. The CONTRACTOR shall be responsible for the installation of the correct pre-cast sections in their designated pump station locations.
- L. Paint all exterior surfaces with two coats of coal tar bitumastic, each coat to be 9 mils each. All interior surfaces of valve vaults shall be coated with two coats of coal tar epoxy (9 mils each).

2.2 PRECAST CONCRETE SECTIONS FOR CIRCULAR WET WELLS

- A. Wet wells shall meet the requirements of ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections, with the exclusion of Section 10(a), except as modified herein. Cement shall meet the requirements of ASTM C150-74, Specification for Portland Cement, Type II. Concrete shall meet the minimum requirement for 4000 psi concrete. Minimum wall thickness shall be 8 inches or 1/8 the inside manhole diameter as shown, whichever is greater. The required minimum strength of concrete shall be confirmed by making and testing three standard cylinders at seven days. Rings shall be custom made with openings to meet indicated pipe alignment conditions and invert elevations. Submit shop drawings, consisting of manufacturers' standard details of various sections for approval prior to placing order for wet wells. Drawings of individual wet wells showing invert elevations, pipe sizes and similar details will not be required.

- B. Joints

Form joint contact surfaces with machined castings. Surfaces shall be exactly parallel with nominal 1/16 inch clearing and the tongue equipped with a proper recess for the installation of an O-ring rubber gasket. Gaskets shall meet the requirements of Specification for Joint for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets. "RAM-NEK" sealing compound conforming to Federal Specification SSS-00210 (GSA-FSS), Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints may be used in lieu of O-ring rubber gaskets. If joints are sealed with "RAM-NEK" sealing compound the recess in the tongue for an O-ring gasket may be omitted.

- C. Wet Well Liners and Coatings

Coat or line (see internal protection on County Approved Product List, Appendix F) the interior of all wet wells.

Furnish, install, test and inspect liners and coating in accordance with manufacturer's recommendations, and in accordance with Section 099723 "Concrete Coatings". Extend coating and liner and seal onto wet well hatch frame, around pipe openings and other protrusions to prevent contact of wet well surface

with corrosive sewer gases. Provide factory or field applied bituminous or epoxy sealer exterior coatings. If exterior coating is factory applied, CONTRACTOR shall provide field touch-up as required.

D. STEEL REINFORCED POLYMER CONCRETE STRUCTURES

As an alternative to the concrete coatings and linings described above, steel reinforced polymer concrete structures may be furnished and installed for pump station wet wells. All steel reinforced polymer concrete structures shall be supplied by a qualified company with a minimum of 5 years' experience manufacturing polymer concrete. All steel reinforced polymer concrete structures shall be manufactured and installed in accordance with the applicable requirements of ASTM C76, C478, C443, D6783, C33, C267, A82, A165, A496, A497, A615, and A615M.

2.3 PIPE CONNECTIONS AT STRUCTURES

- A. Where pipes are to extend into or through structures from the exterior, provide flexible connections (mechanical or push-on type joints) at the exterior wall face.
- B. For pipes passing through structural walls, install wall pipes with water stops where the location is below the surface of the ground or at any point where fluid levels will exceed that elevation. Neoprene sleeves with watertight caulking and 316 Series SS stainless steel clamps will be suitable at other locations.
- C. All of the following conditions apply to any proposed pipe penetration into an existing sanitary manhole:
 - 1. The opening for the penetration must be core bored and fitted with a neoprene sleeve as specified above.
 - 2. The core boring or penetration shall not affect a structural joint, and the boring edge must be no closer than six inches to an existing structural joint.
 - 3. The proposed piping within the manhole must comply with all other provisions of these Utilities Standards.
 - 4. Connections requiring drop pipes shall be constructed in accordance with these Utilities Standards and shall require two penetrations.
 - 5. The existing manhole flume or invert must be modified as required to accept the discharge from the proposed pipe.
 - 6. The interior lining of the existing structure including flume or invert shall be repaired by an approved applicator for the lining system.

7. Any damage to the exterior coating of the existing structure shall be repaired with two coats of coal tar epoxy (9 mils each) in accordance with the manufacturer's recommendations.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Control ground water to provide firm, dry subgrade for the structure, and prevent water rising on new poured in place concrete or grouted joint sections within 24 hours after placing. Guard against flotation or other damage resulting from ground water or flooding.
- B. Place a 12-inch layer (minimum thickness) of crushed stone or shell as specified under Section 312323 as a foundation for the wet well base slabs, valve pits, and meter pits.
- C. Provide backfill material around the wet well and above the pipe bedding as specified in Section 312323.
- D. Precast bases, conforming to all requirements of ASTM C478 and above listed requirements for precast sections, may be used. Set the base in place on a thoroughly compacted crushed stone sub-base and adjust grade for the correct structure elevation.
- E. Do not set the station into the excavation until the installation procedure and excavation have been approved by the County Manager or designee.
- F. The base may be cast-in-place concrete as specified in Division 3, placed on a thoroughly compacted crushed stone sub-base. Shape the tops of the cast-in-place bases to mate with the precast barrel section, and adjust in grade so that the top slab section is at the approximately correct elevation.
- G. Set the precast concrete structure sections so as to be vertical and with sections in true alignment with a 3 inch maximum tolerance to be allowed. Fill the outside and inside joint with a non-shrink grout and finish flush with the adjoining surfaces. Allow joints to set for 24 hours before backfilling. Backfill in a careful manner, bringing the fill up evenly on all sides. If leaks appear in the structures, caulk the inside joints with lead wool to the satisfaction of the ENGINEER. Install the precast sections in a manner that will result in a watertight joint.
- H. Plug holes in the concrete sections required for handling or other purposes with a non-shrinking grout or by grout in combination with concrete plugs.

SECTION 055600
METAL CASTINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Miscellaneous ferrous and nonferrous castings.
1. This classification includes wheel guards, valve boxes, manhole frames and covers, manhole steps, stop plank grooves, brackets and supports for piping and gutter inlets, floor drains, cleanouts and special malleable iron castings and inserts.

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
1. ASTM A 27/A27M - Specification for Steel Castings, Carbon for General Applications
 2. ASTM A 47 - Specification for Ferric Malleable Iron Castings
 3. ASTM A 48 - Specifications for Gray Cast Iron Castings
 4. ASTM A 148/A148M - Specifications for Steel Castings
 5. ASTM A 536 - Specifications for Ductile Iron Castings
 6. ASTM B 26/B26M - Aluminum
 7. ASTM B 148 - Aluminum Bronze Sand Castings
 8. ASTM B 584 - Manganese Bronze

PART 2 PRODUCTS

2.1 WORKMANSHIP

- A. Provide castings accurately made to the approved dimensions, and plane or grind castings where marked or where otherwise necessary to secure flat and true surfaces. Make allowance in the patterns so that the specified thickness is not reduced. Provide manhole covers which conform to the details shown and which are true and seat at all points. Supply castings showing the name of the manufacturer and the country of manufacture. No plugging or welding of defective castings will be permitted.

2.2 WEIGHTS

- A. Reject castings with a weight which is less than the theoretical weight based on required dimensions by more than 5 percent. Provide facilities at the site for weighing castings in the presence of the ENGINEER, or furnish invoices showing true weights, certified by the supplier.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Erect all castings to accurate grades and alignment, and when placing in concrete carefully support castings to prevent movement during concreting.

3.2 PAINTING

- A. Deliver all manhole castings to the job site unpainted. If painting is specified, clean metal castings thoroughly before painting. Give manhole frames and covers and valve boxes one coat of primer and two coats of an approved asphaltum varnish or other approved coating at the point of manufacture. Paint all other castings as specified in the Collier County Standard Details.

END OF SECTION

SECTION 099723
CONCRETE COATINGS

PART 1 SEWPERCOAT LINING SYSTEM / IET COATING SYSTEM / RAVEN 405 LINING SYSTEM

1.1 SCOPE OF WORK

- A. This section provides details for furnishing and installing the SewperCoat lining system where shown on the drawings for protection of concrete structures against hydrogen sulfide corrosion. Perform installation by workers experienced in the application of the lining system to be used.
- B. This section provides details for furnishing and installing the Integrated Environmental Technologies (IET) coating system where shown on the drawings for protection of concrete structures against hydrogen sulfide corrosion. Perform installation by workers experienced in the application of the coating to be used.
- C. This section provides details for furnishing and installing the Raven 405 coating system where shown on the drawings for protection of concrete structures against hydrogen sulfide corrosion. Perform installation by workers experienced in the application of the coating system to be used.
- D. For sanitary sewer wet wells and manholes, steel reinforced polymer concrete structures may be provided in lieu of concrete coatings and linings as described in this section. See Sections 034100 and 333913 for further details and requirements.

PART 2 PRODUCTS

2.1 SEWPERCOAT LINING SYSTEM

- A. The SewperCoat (calcium aluminate) lining system shall be as manufactured by Lafarge Calcium Aluminates, Chesapeake, VA.
- B. Pure-fused Calcium Aluminate Cement Lining: The cement lining material shall be a pure fused calcium aluminate mortar with pure fused calcium aluminate aggregate equal to SewperCoat as manufactured by Lafarge Calcium Aluminates, Inc. The material shall be spray applied in accordance with the manufacturer's specifications.
 - 1. The material shall be packaged from the manufacturer so as not to require field mixing of mortar and aggregate to obtain recommended composition.
 - 2. The material shall form a mechanical and chemical bond to the wetwell surface with zero shrinkage. The material shall have a minimum 28-day compressive strength of 9000 psi.

3. The material shall be suitable for use in a severe hydrogen sulfide (H₂S) environment.
4. Provide documentation that the material has a minimum 5-year history in the reconstruction of sanitary sewer structures.

2.2 IET COATING SYSTEM

- A. The IET Coating System shall be as manufactured by Integrated Environmental Technologies, Santa Barbara, CA.
- B. Polymorphic Resin shall be a 100% solids, two-component, highly modified polyester resin system, exhibiting no adhesion-interfering shrinkage upon curing. Resin shall cure rapidly within fifteen minutes to one hour without the use of heat or cooling at surface temperatures ranging from –30 degrees Fahrenheit to over +150 degrees. Excellent resistance to a broad range of corrosive chemicals, including sulfuric acid created by hydrogen sulfide gas as well as other chemicals typically found in sanitary sewers, and impact and abrasion attack shall be provided.

2.3 RAVEN 405 COATING SYSTEM

- A. The RAVEN 405 coating system shall be as manufactured by Raven Lining Systems, Broken Arrow, OK.
- B. Raven 405 coating shall be 100% solids, solvent-free ultra high-build epoxy system exhibiting the following characteristics:
 1. Product Type: amine cured epoxy
 2. VOC Content (ASTM D2584): 0%
 3. Compressive Strength, (ASTM D695): 18,000 psi
 4. Tensile Strength, (ASTM D638): 7,600 psi
 5. Flexural Modulus, (ASTM D790): 700,000 psi
 6. Adhesion to Concrete, (ASTM D4541/7234): >200 psi with substrate (concrete) failure
 7. Chemical Resistance (ASTM D543/G20) immersion service for:
 - a. Municipal sanitary sewer environment
 - b. Sulfuric Acid, 30%
 - c. Sodium Hydroxide, 10%

- d. Sodium Hypochlorite, 3%
- 8. Successful Pass: Sanitation District of L.A. County Coating Evaluation Study and SSPWC 210.2.3.3 (Greenbook "Pickle Jar" Chemical Resistance test)

2.4 STEEL REINFORCED POLYMER CONCRETE STRUCTURES

- A. As an alternative to the concrete coatings and linings described above, steel reinforced polymer concrete structures may be furnished and installed. All steel reinforced polymer concrete structures shall be supplied by a qualified company with a minimum of 5 years' experience manufacturing polymer concrete.
- B. All steel reinforced polymer concrete structures shall be manufactured and installed in accordance with the applicable requirements of ASTM C76, C478, C443, D6783, C33, C267, A82, A165, A496, A497, A615, and A615M.
- C. Approved manufacturers: See County Approved Product List, Appendix F.

PART 3 EXECUTION

3.1 SEWPERCOAT LINING

- A. Plug or bypass all pipes in service before any work is started on the structure. No debris is to be flushed down the line.
- B. Anyone entering the structure must conform to all OSHA requirements for "Confined Space Entry" equipment and permitting.
- C. Prepare surface in accordance with the requirements of SewperCoat Data Sheets on Concrete Preparation. Interior surfaces of wetwell shall be sound, porous, dry, and free of dust, dirt, oil, grease and other contaminants prior to application of lining.
- D. Interior surface of structure must be abrasive-blasted to remove all loose patching, old coatings and any contamination in the concrete. Do not use silica sand.
 - 1. Abrasive-blast "new" structures to remove all oils and patch mud, and to open pinholes and expose aggregate.
 - 2. Abrasive-blast "rehab" structures to remove all loose patching, old coatings, and any contamination that penetrated the concrete. The finished interior of the structure shall be gray. Coat the exposed invert/floor also. Where there is severe deterioration of the mortar, place new concrete to match the original interior dimensions after abrasive blasting and removal of all loose material and by-products of corrosion. Restore invert/floor to the original elevation.
 - 3. Vacuum to remove all abrasives and debris.

4. Condition of the wetwell may require the use of a 10% solution of hydrochloric (muriatic) acid over all surfaces or the use of a detergent. If an acid or detergent solution is used, the surface shall be thoroughly rinsed and neutralized prior to the installation of the liner system.
- E. Repair all leaks by injecting grout using Avanti Multi-grout AV-202 or equivalent. Hydraulic cement shall not be used to stop any water leaks.
- F. Spray Application: Mix and apply the pure fused calcium aluminate cement liner system in strict accordance with the manufacturer's written instructions using only manufacturers approved equipment. This includes the preparation, installation, curing and finish operation required for the completion of the process.
 1. Wet gun: Spray the material directly to the damp wetwell surface in a two-coat application. Trowel the material smooth after each coat, completely covering the interior surface of the wetwell from the frame to the invert with a minimum thickness of 1 inch. Apply a "brushed" finish to the second coat after troweling.
 2. Dry Gun: Spray the material directly to the damp wetwell surface in a one-coat application. Trowel the material smooth after the application, completely covering the interior surface of the wetwell from the frame to the invert with a minimum thickness of 1 inch. Apply a "brushed" finish after troweling.
- G. Curing: The material shall cure in strict accordance with the manufacturer's recommendations and instructions.
- H. Inspect lining system for holidays (i.e., discontinuity), cracks and pinholes. Take particular care to check lining over brick, block, heavy spalled surfaces, and other very rough surfaces and locate holes in the lining caused by voids in bricks, block, concrete and structure joints. Fill voids and holidays in accordance with the lining system manufacturer's instructions.
- I. Provide a five (5) year unlimited warranty on all workmanship and products. The work includes the surface preparation and application of the SewperCoat lining system, and shall protect the structure for at least five (5) years from all leaks, and from failure due to corrosion from exposure to corrosive gases such as hydrogen sulfide.

3.2 IET COATING

- A. Plug or bypass all pipes in service before any work is started on the structure. No debris is to be flushed down the line.
- B. Anyone entering the structure must conform to all OSHA requirements for "Confined Space Entry" equipment and permitting.

- C. Prepare surface in accordance with the requirements of IET Systems Data Sheets on Concrete Preparation. Interior surfaces of manhole shall be sound, porous, dry, and free of dust, dirt, oil, grease and other contaminants prior to application of lining.
- D. Dry abrasive-blast Interior surface of structure to remove all loose patching, old coatings and any contamination in the concrete. Do not use silica sand.
 - 1. Dry abrasive-blast “new” structures to remove all oils and patch mud, and to open pin holes and expose aggregate.
 - 2. Dry abrasive-blast “rehab” structures to remove all loose patching, old coatings, and any contamination that penetrated the concrete. The finished interior of the structure shall be gray. Coat the exposed invert/floor also. Where there is severe deterioration of the mortar, place new concrete to match the original interior dimensions after abrasive blasting and removal of all loose material and by-products of corrosion. Restore invert/floor to the original elevation.
 - 3. Vacuum to remove all abrasives and debris.
- E. Repair all leaks by injecting grout using Avanti Multi-grout AV-202 or equivalent. Hydraulic cement shall not be used to stop any water leaks.
- F. Clean and remove dust material with pressure washing for maximum adhesion. Blow dry concrete at 250 cfm with 120 psi.
- G. Apply IET Systems Coating by the use of the IET Systems Spray Unit and IET Systems Spincaster. Apply IET coating at least three different intervals – prime coat, intermediate coat and finish coat, per IET Systems manufacturer instructions and specifications. The total thickness of the IET coating shall be at least 125 mils.
- H. Inspect lining system for holidays, cracks and pinholes. Take particular care to check lining over brick, block, heavy spalled surfaces, and other very rough surfaces and locate holes in the lining caused by voids in bricks, block, concrete and structure joints. Fill voids and holidays in accordance with the lining system manufacturer’s instructions.
- I. Provide a five (5) year unlimited warranty on all workmanship and products. The work includes the surface preparation and application of the IET coating system, and shall protect the structure for at least five (5) years from all leaks, and from failure due to corrosion from exposure to corrosive gases such as hydrogen sulfide.

3.3 RAVEN 405 COATING

- A. Plug or bypass all pipes in service before any work is started on the structure. No debris is to be flushed down the line.
- B. Anyone entering the structure must conform to all OSHA requirements for “Confined Space Entry” equipment and permitting.

- C. Prepare surface in accordance with the requirements of Raven Data Sheets on Concrete Preparation. Interior surfaces of structure shall be sound, porous, dry, and free of dust, dirt, oil, grease and other contaminants prior to application of lining.
- D. Dry abrasive-blast Interior surface of structure to remove all loose patching, old coatings and any contamination in the concrete. Do not use silica sand.
 - 1. Dry abrasive-blast “new” structures to remove all oils and patch mud, and to open pin holes and expose aggregate.
 - 2. Dry abrasive-blast “rehab” structures to remove all loose patching, old coatings, and any contamination that penetrated the concrete.
 - 3. Vacuum to remove all abrasives and debris.
- E. New Portland concrete structures shall have a minimum of 28 days cure since manufacture prior to commencing coating installation.
- F. Offset structural components, lids, covers, frames, etc. shall be repaired, replaced, or reset prior to the commencement of surface preparation.
- G. Concrete and/or mortar damaged by corrosion, chemical attack or other means of degradation shall be removed so that sound substrate remains.
- H. In conditions where severe chemical/microbiological attack is present the prepared substrate shall exhibit a pH of 8-12. Additional cleaning and/or contaminated substrate removal may be required to achieve the specified pH level.
 - 1. Prior to the application of the coating product repairs shall be completed to ensure the following:
 - 2. All inflow and infiltration shall be eliminated by use of appropriate repair material(s), such as hydraulic cements and/or chemical grouts as described in Section 2.2.
 - 3. All repairs to joints, pipe seals, steps, mechanical penetrations, benches, inverts, pipes or other appurtenances to be coated shall be completed and repaired surfaces prepared according to this section.
 - 4. Benches or other horizontal surfaces shall have adequate slope (1” rise per lineal foot minimum) to minimize the retention of debris following surcharge.
 - 5. Inverts or flow channels shall be smooth without lips, rough edges or other features which may cause debris to collect; contoured to minimize turbulent flow; and be sloped to promote adequate flow from the inlet(s) to the outlet pipe.

6. All joints, pipe seals, steps or other penetrations shall be sealed against inflow, infiltration and exfiltration and be adequately filled, smoothed and contoured to promote monolithic coating application.
- I. Areas where reinforcing steel has been exposed shall be repaired in accordance with the Project Engineer's recommendations or at the minimum all exposed steel shall be prepared in accordance with Section 3.2 prior to coating with the coating product specified or other approved primer as specified by the coating product manufacturer.
- J. Coating shall be applied to a minimum dry film thickness of 80 mils to surface profiles of CSP-4 to CSP-5 or 125 mils minimum DFT to surface profiles of CSP-6 or greater and in rehabilitated structures.
- K. Subsequent top coating or additional coats of the coating product(s) shall occur within the products recoat window. Additional surface preparation procedures will be required if this recoat window is exceeded.
- L. Provide a five (5) year unlimited warranty on all workmanship and products. The work includes the surface preparation and application of the Raven 405t lining system, and shall protect the structure for at least five (5) years from all leaks, and from failure due to corrosion from exposure to corrosive gases such as hydrogen sulfide.

END OF SECTION

SECTION 221336

DIESEL BACKUP PUMP

PART 1 GENERAL

1.1 SCOPE

- A. Requirements for providing a permanently installed automatically starting pump station back-up pumpset.
- B. Elevated platforms shall be provided where necessary to provide access to the diesel backup pump for operation and maintenance. Typically, these platforms shall be limited to locations with existing grades requiring equipment to be located at a higher elevation due to the Florida Building Code (FBC), FEMA, and the ASCE Standard 7 and 24 requirements.

1.2 GENERAL

- A. The specifications herein state the minimum requirements of Collier County (the Owner). All bids must be regular in every respect. Unauthorized conditions, limitations, or provisions shall be cause for rejection. The Owner may consider as "irregular" or "non-responsive", any bid not prepared and submitted in accordance with the bid documents and specification, or any bid lacking sufficient technical literature to enable the Owner to make a reasonable determination of compliance to the specification. It shall be the bidder's responsibility to carefully examine each item of the specification. Failure to offer a completed bid or failure to respond to each section of the technical specification (exception yes or no) will cause the proposal to be rejected, without review, as "non-responsive". All variances, exceptions, and/or deviations shall be fully described in the appropriate section. Deceit in responding to the specification will be cause for rejection.
- B. INTERPRETATIONS: In order to be fair to all bidders, no oral interpretations will be given to any bidder as to the meaning of the specifications documents or any part thereof. Every request for each a consideration shall be made in writing to the Owner. Based upon such inquiry, the Owner may choose to issue an Addendum in accordance with local public contract laws.
- C. GENERAL SPECIFICATIONS: Units described shall be new, unused, and of the current year's production. The style of pump being bid must be in production for a minimum of 5 years (include users list). Unit shall be of the latest design and in current production completely serviced, ready for work and shall include all standard and optional equipment as specified herein. All bidders must have demonstrated the unit they are bidding, prior to bid date.
- D. Bidders must have a fully stocked parts and service facility within 50 miles of the project site. The Owner shall have the right to inspect the office and shall be the sole judge of its adequacy to fulfill this requirement.

- E. Bidders, on request of the Owner, must be prepared to review their specifications with the Owner and must, if requested, also be prepared to provide a unit for tangible evaluation purposes only. These services, if needed, are considered as part of the bidder's proposal and will be provided without cost or obligation to the Owner.

1.3 SYSTEM DESCRIPTION

- A. The pumpset specified in this section will be used to pump wastewater from a Collier County pumping station (PS).
- B. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing.
- C. The complete pump set shall be supplied by the pump manufacturer.
- D. The pump offered shall be the manufacturer's standard production model. It shall have been in continuous use by municipal and industrial owners for a minimum of five years. A list of five user contacts including contact names and telephone numbers shall be provided with the bid submittal. Failure to supply a verifiable users list will be cause for rejection of the bid.

1.4 DESIGN REQUIREMENTS

- 1.4.1 All design requirements listed below must be clearly displayed on performance pump curves. These performance pump curves shall be based on testing standards established by the hydraulic institute.

DESIGN REQUIREMENTS	
OPERATING SPEED (MAXIMUM) (RPM)	
MAXIMUM SOLIDS HANDLING SIZE (INCHES)	
IMPELLER DIAMETER (INCHES)	
SUCTION SIZE (INCHES)	
DISCHARGE SIZE (INCHES)	
PRIMARY DUTY POINT (GPM @ TDH)	
MAXIMUM SUCTION LIFT AT PRIMARY DUTY POINT (FEET)	
MINIMUM EFFICIENCY AT MAX DUTY POINT	
SECOND DUTY POINT (GPM @ TDH)	
MAXIMUM SUCTION LIFT AT SECOND DUTY POINT (FEET)	
MINIMUM EFFICIENCY AT SECOND DUTY POINT	

1.5 REFERENCES

1. ANSI B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings.

PART 2 PRODUCTS

2.1 PRE-APPROVED ACCEPTABLE MANUFACTURERS:

1. GODWIN PUMPS OF AMERICA
 2. THOMPSON PUMP & MANUFACTURING CO, INC.
- A. All manufacturers shall be ISO 9001: 2008 certified. Certificates shall be made available to Collier County upon request. Bids will be accepted for consideration on any make and model that meets the requirements of the project specifications, as interpreted by the Owner. If a product proposed does not meet the requirements of this specification, the Contractor shall provide a unit which does, at no additional cost to the Owner. The Owner shall have the final decision on which products do and which products do not meet the project specifications.

2.2 EQUIPMENT

- A. PUMPS: The pumps used in the diesel backup pump system shall be supplied directly by the manufacturer, not by a distributor. The pump itself and the diesel backup pump system as a whole shall come from a single manufacturer. "Packagers" of systems which incorporate pumps from a separate manufacturer to fabricate diesel backup pump systems shall not be allowed.
- B. CASING, SUCTION COVER, SEPARATION TANK: Pump castings shall be cast iron or ductile iron with a minimum pressure rating of 100 psi. The pump casing shall be constructed so that the suction flow path is in axial alignment with the impeller eye. There shall be no turns, chambers, obstructions or straightening vanes between the suction line and the impeller. The pump casing shall be complete with a removable port for inspecting impeller/cut water area.
- C. IMPELLERS: The pump impeller shall meet the criteria of one of the following:
1. An open, three-bladed, (or 2-bladed) non-clog type with pump-out vanes on the back shroud and fabricated from hardened cast- chromium steel construction (or other material to meet minimum Brinell Hardness 340 HB).
 2. A high efficiency non-clog type, 2-vane, enclosed design with full front and rear shrouds, containing back pumpout vanes, constructed of high grade 65-45-12 ductile iron and capable of passing a 3" spherical solid.
- D. WEARPLATES/WEAR RINGS: Shall be fully be replaceable, fabricated of cast iron. Wear plate/wear ring clearances shall have no relationship to the ability of the pump to achieve a prime.
- E. BEARINGS AND SHAFTS: Pump shall be fitted with a bearing bracket to contain the shaft and bearings. Bearings shall be tapered roller bearings of adequate size to withstand imposed loads for sustained pumping at maximum duty points. Minimum ISO L₁₀ bearing life to be 100,000 hours. Impeller shafts shall be fabricated of high strength alloy steel, accurately machined, polished, and of sufficient size to transmit full driver output without excessive flexing or stress.

- F. SEALS: Pump shall be capable of running dry, with no damage, for periods up to twenty-four hours. The pump seals shall be the requirements of one of the following:
1. Seal shall be high pressure, mechanical self-adjusting type with silicon carbide faces capable of withstanding suction pressures to 87 psi. The mechanical seal shall be cooled and lubricated in an oil bath reservoir, requiring no maintenance or adjustment. All metal parts shall be of stainless steel. Elastomers shall be Viton.
 2. Pump seal shall be an inside-mounted, self-cleaning John Crane type 2 component style mechanical seal with tungsten carbide rotating and silicon carbide stationary faces with Viton elastomers and stainless steel spring and hardware.
- G. PUMP SUCTION AND DISCHARGE FLANGES: Shall be cast iron ANSI (B16.1) Class 150, raised faced.
- H. PUMP GASKETS: Shall be compressed fiber and/or Teflon.
- I. PUMP O RINGS: Shall be Buna-N.
- J. PRIMING SYSTEM: Pump shall be fitted with a fully automatic priming system incorporating a air compressor, venturi (with lifetime warranty), priming chamber, and discharge check valve assembly. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated and cooled from the engine. Installed system design shall prevent any carryover of the pumping fluid onto the ground. Priming system may require additional drainage pipelines to be constructed to re-circulate pumping fluid back to sump area. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system is capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts to 28 vertical feet, at sea level. It shall also be capable of operation using extended suction lines, and pump shall be capable of priming and re-priming without any user intervention. Equipment acceptance shall be contingent upon the pump's ability to run continuously at full speed in a completely dry condition. The engineer may require a demonstration. Priming systems that incorporate the use of a positive displacement diaphragms OR oil-cooled vacuum pumps will not be accepted.
- K. CHECK VALVE: The priming system shall include a discharge check valve to prevent pulling air through the discharge line during priming and prevent in-line return of flow when the pump is shut off. Non-return check valve shall be constructed of cast iron with Nitrile rubber and shall be field replaceable. Check valve shall be vacuum-tested by the factory, and test results shall be provided.
- L. DRIVE UNIT: The drive unit shall be a diesel water-cooled engine. The engine shall drive the pump by use of direct-connected intermediate drive plate. Starter shall be twelve-volt electric. Low oil pressure safety shutdown, high temperature shutdown, tachometer, and hour-meter shall be integrated into engine control panel. Battery shall have 180-amp hour rating. A certified continuous-duty engine curve shall be supplied to the owner/engineer.

- M. GOVERNOR: Governor shall be an electronic or mechanical type. Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode. See section 2.3 for Automatic mode.
- N. FUEL SOURCE: Integral skid fuel tank capacity shall be sufficient to provide at least seventy-two (72) hours of continuous operation at full load. The minimum tank size shall be 150 gallons and the maximum tank size shall be 550 gallons. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.
- O. EXHAUST: Exhaust system shall include a hospital grade muffler housed in a separate chamber within the enclosure. All exhaust piping and manifolds shall be encased in fitted acoustic blankets. They shall be constructed of high-density fiberglass material with waterproof jacketing.
- P. SOUND ATTENUATED ENCLOSURE: The entire unit including the pump and engine shall be completely enclosed in a lockable enclosure. The enclosure shall be constructed with a modular galvanized steel frame and galvaneel panels. Acoustical material shall be installed as required to reduce pump and engine noise. Maximum sound ratings for specific pump sizes are shown in the table below. These sound ratings shall be the maximum dBA rating measured at 7 meters @ both duty points specified.

Pump Outlet Size	Maximum Sound Rating Allowed
4"	68 dBA
6"	70 dBA
8"	72 dBA
10"	72 dBA
12"	72 dBA

- Q. Units not meeting this requirement shall not be considered. The enclosure shall be removable for easy access to the engine / pump for maintenance and repair. The enclosure doors shall all be equipped with latches that are keyed alike. For maintenance and service needs, the enclosure sides shall have hinged doors for quick access to the engine oil fill, fuel fill port, oil dipstick, and filters. The enclosure shall be coated in epoxy based primer and paint to a total dry film thickness of 5 mils.

R. UL LISTED SKID BASE

1. The pump base tank shall be a UL-142 approved double wall design constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; The Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and The Standard for Emergency and Standby Power Systems, NFPA 110. Pumps installed within 25 feet of a building shall be equipped with UL-2085 fire resistant fuel tanks. All fuel tanks shall comply with the requirements set forth by Collier County Pollution Control.
2. The tank design shall be a Closed Top Dike Pump Base Tank. It shall be of double

wall construction having a primary tank to contain the diesel fuel, held within another tank or dike, which is intended to collect and contain any accidental leakage from the primary fuel tank. The completed base tank assembly is to incorporate pump mounting locations and must be able to support four times the rated load.

3. The primary tank shall be designed to withstand normal and emergency internal pressures and external loads. It shall be capable of withstanding internal air pressures of 3 to 5 psig without showing signs of excessive or permanent distortion and 25 psig hydrostatic pressures without evidence of rupture or leakage.
4. The primary and secondary tanks or dike shall have venting provisions to prevent the development of vacuum or pressure capable of distorting them as a result of the atmospheric temperature changes or while emptying or filling. The vent shall also permit the relief of internal pressures caused by exposure to fires. The vent size shall be determined by using the calculated wetted surface area in square feet (the top is excluded) in conjunction with venting capacity table 10.1 of UL-142. The tank's vent shall also be equipped with a coupling device and shall be located to facilitate connection to a vent piping system. The dike's vent may be an opening for venting directly to the atmosphere and protection from the entrance of natural elements or debris shall be provided.
5. The primary and outer tanks are to be constructed of 304 stainless steel, 7 gauge minimum. Internal baffles or reinforcement plates shall be located on a maximum of 24 inch centers in tanks up to 60 inch width and on a maximum of 19.5 inch centers in tanks over 60 inch width. At least one baffle shall separate the fuel suction pipe from the fuel return line.
6. The outer tank is to be constructed in a manner to be able to support four times the wet load of the pump and housing. The entire load is to be carried by the outer tank so no load or vibration stress is placed on the primary tank. If the pump base tank is wider than the pump set to be supported, structural rails are to be incorporated to span the width of the base tank so that the load is transferred to the side rails of the tank. Vertical reinforcements shall be welded to the outer sides of the secondary tank or dike at a maximum of 45 inch centers on tanks up to 30 inches high and on 24 inch centers on tanks greater than 30 inches high. At least one vertical reinforcement shall be positioned adjacent to each mounting hole location. Provide level monitoring and interstitial space leak monitoring.
7. Both primary and secondary tanks shall be fitted with the proper welded pipe fittings to accommodate the requirements for the fill port and normal and emergency venting.
8. The completed assembly is to be cleaned with a heated pressure wash followed by a chromium free post treatment to ensure proper paint adhesion. The tank assembly is to be painted with an epoxy ester primer and high quality polyurethane enamel with a minimum dry film thickness of 3.5 mils.
9. All tanks shall be tested in accordance with **NFPA 30 TO INCLUDE ON SITE**

TIGHTNESS TESTING in accordance with NFPA 30 Section 21.5. This requirement shall not apply to portable trailer mounted diesel pumps.

10. Manufacturing and testing of this system shall be performed within the scope of Underwriters Laboratories, Inc. "Standard for Safety UL 142.", or UL 2085, as applicable. A UL label shall be permanently attached to the tank system showing the following information:

- i. The registered UL mark and the name: Underwriters Laboratories, Inc.
- ii. A control number and the word "listed"
- iii. The product's name as identified by Underwriters Laboratories Inc.
- iv. The serial number assigned by Underwriters Laboratories, Inc.
- v. Other manufacturer's information may also be included.

S. PORTABLE TRAILER (FOR TRAILER MOUNTED UNITS ONLY):

- 1. The complete pump set shall be factory mounted on a highway trailer meeting NHTSA, DOT Part 571 standards 108, 119 and 120.
- 2. Trailers with loads of 5,000 pounds or less with fuel tank filled, shall have a flat bed, single axle, two 15-inch wheels with 6-ply tires. Axle ratings shall be a minimum of 5,000 pounds.
 - i. Trailers with loads from 5,000 to 10,000 pounds with fuel tank filled, shall have a flat bed, 2-axle, four 15-inch or 16-inch wheels with 10-ply tires. Axle rating shall be a minimum of 10,000 pounds.
 - ii. Trailers above shall have following accessories. Ring and pintal hitch including safety chain and fasteners, electric brakes shall be provided on all wheels, and all required ICC lights such as tail, brake, direction signals, license holder and light, etc., shall be provided; jacks and sand shoes for front and rear corners shall be provided so that unit can be completely supported.
 - iii. The diesel backup pump engine shall be balanced mounted on trailer. All necessary service and checkout of diesel backup pump set shall be performed prior to delivery.

T. FACTORY PAINTING: Pump, engine, and base shall be shop primed and finish painted at the place of manufacturer.

2.3 AUTOMATIC STARTING CONTROL SYSTEM

- A. The engine control panel shall be provided in a NEMA 3R enclosure mounted on rubber isolators to reduce vibration, equipped with a factory installed microprocessor-based controller designed to start/stop the engine at a signal supplied by high and low level floats or a 4-20 mA transducer.
- B. The control system shall be able to start/stop the engine a via a signal supplied by a primary level transducer and back-up high and low level floats for redundant automatic operation.

C. ENGINE / PUMP CONTROL SPECIFICATIONS

1. The engine shall be started, stopped, and controlled by a digital controller. The controller shall be weather proof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine based on relay contact closure provided by others. The controller shall provide the following functions without modification, factory recalibration, or change of chips or boards, by simply accessing the keypad:
 - D. The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, and maintain complete weather-tight sealing of the controller.
 - E. In automatic mode, the unit shall conserve energy and go to "sleep".
 - F. The controller shall function interchangeably from remote contact closure, as well as manual start/stop by selection at the keypad. No other equipment or hardware changes are required.
 - G. The start function can be programmed to provide two separate functions each day for seven days (i.e. a start, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).
 - H. Manual-Automatic Button:
 1. In Manual Mode, manual "Start" button starts engine and runs until "Stop" or "Off" button is depressed or an emergency shutdown occurs.
 2. In Automatic Mode, start/stop sequencing is initiated by a signal from a digital input.
 - I. The controller shall integrate the engine safety shut-off for low and high oil temperature, and provide over-speed protection.
 - J. The controller shall include standard, field-adjustable parameters for engine cycle crank timer, and shutdown time delay.
 - K. The controller shall have only one circuit board with eight built-in relays. Three (3) of the relays shall be programmable to output desired parameter on display and to be used as dry-contacts for communication with Collier County's SCADA system, all via the keypad without changing relays, chips, printed circuits, or any hardware or software. Relays will monitor the following:
 1. Low Battery Charge
 2. Low Fuel Level (Less than 25 gallons)
 3. Diesel Pump Engine Start
 - L. Standard components shall consist of one of the following set ups:

1. (24) Digital inputs, (7) analog inputs, (1) magnetic pick-up input, (8) 20-amp form "C" relays, (1) RS232 port, (1) RS485 port, (1) RS232/RS485 port, (1) J1939 port, and (1) 64X128 pixel full graphic LCD display with backlight.
 2. (8) Digital inputs, (5) analog inputs, (8) digital outputs, (1) RS232 port, (1) RS485 port, (1) J1939 port, (76) selectable features, (32) alarm event history.
- M. The industrially-hardened Controller shall withstand vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature range of 4° to 176°F (-20° to 80°C) and an operating humidity range of 0-95% non-condensing.

2.4 OPTIONS

- A. FULLY AUTOMATIC TRICKLE CHARGER: The unit shall include a fully automatic trickle charger powered by 6-amps, 115 VAC.
- B. LIGHT: The unit shall include a single switch operated 12VDC light within the enclosure.
- C. FLOATS: The unit shall be supplied with one (1) float assembly including two (2) N/O floats which shall integrate with the engine control panel via a single multi-pin plug.
- D. LEVEL TRANSDUCER: The unit shall be supplied with (1) one Teflon diaphragm sewage compatible level transducer assembly including a single 4-20 mA level transducer with leveling guard (0-15 psig), which shall integrate with the engine control panel via a single multi-pin plug.
- E. AUTO THROTTLE: The unit/s shall include one (1) automatic throttle controller integrated into (1) relays in the electronic engine control panel. The auto-throttle control panel combination shall allow the pump to ramp up to the target RPM given a start command and ramp down to idle given a stop command via the 4-20 mA level transducer.
- F. DC / AC INVERTOR: The unit/s shall include one (1) 12VDC to 110VAC volt single-phase inverter, 1750 watts, mounted inside enclosure, single 15-amp GFI outlet, and one (1) fusible link.

2.5 ACCESS PLATFORM

- A. Platforms and stairs shall meet the Occupational Safety and Health Administration (OSHA) Part 1910, applicable FBC requirements, and ASCE Standards 7 and 24. All platform and stair designs and plans shall be prepared by a Florida Registered Professional Engineer. The Engineer of Record shall identify Flood Hazard Area, Flood Design Class (ASCE 24) and other applicable loadings. All components shall be aluminum with stainless steel hardware. Standard stairs shall be utilized. Fall protection shall be provided on all exposed sides by use of an OSHA approved guardrail system. Where required for access, removable guardrail sections shall be provided. Grating shall be slip resistant and banded at ends of bearing bars and openings.

- B. All platforms and stairs shall be supported by a concrete foundation system. The foundation designs and plans shall be prepared by a Florida Registered Professional Engineer. It shall meet the requirements of the FBC, ASCE 7 (Dead, Live, Flood, and Wind), ASCE 24 (Flood Resistant) and other regulatory requirements. Where head clearance under the platform is less than 6'-8", provisions shall be made to limit access.

PART 3 EXECUTION

3.1 MANUFACTURERS SERVICES

- A. The manufacturer shall furnish the services of a competent factory representative to do the following:
 - 1. The complete pump set shall be factory tested according to ANSI/HI 1.6-1994 by a certified quality technician. The pump shall be sound tested according to ISO 3744, ANSI/HI9.4 and CPB Sound Level Measurement Standard.
 - 2. Instruct the Owner's operating personnel in the proper operation and maintenance of the system for a period of not less than one-half day.

3.2 TOOLS AND SPARE PARTS

- A. The manufacturer shall furnish the following on delivery of the pumping system;
 - 1. A recommended list of spare parts.
 - 2. Two (2) replacement mechanical seals
 - 3. An Operations and Maintenance manual for the pump and engine.
 - 4. A fuel polishing system capable of below 1 micron filtration equipped with a fuel-water separator and 12V DC fuel pump rated at 40 GPH minimum. The system shall be a standard commercial or industrial off the shelf unit intended for portable use of diesel fuel polishing. The fuel polishing system shall include 6 spare filters and an operations and maintenance manuals.

3.3 WARRANTY

- A. The manufacturer shall furnish the following to the owner:
 - 1. A copy of the engine manufacturer's parts and labor warranty.
 - 2. A 3-year Parts and Labor Warranty issued by the manufacturer on the Diesel Pump System. This warranty must cover all pump parts.
 - 3. The venturi shall have a minimum five (5) year warranty to include parts and labor.

END OF SECTION

SECTION 263213.13

STANDBY DIESEL GENERATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of diesel generator set work as indicated by Drawings and Schedules, and is hereby defined to include, but not by way of limitation:
 - 1. Diesel engine.
 - 2. Electrical generator.
 - 3. Engine starting system.
 - 4. Batteries.
 - 5. Instrument control panel.
 - 6. Sound Attenuating Enclosure.
 - 7. Sub-Base Fuel Tanks.
 - 8. Exhaust silencer.
 - 9. Wall thimble.
 - 10. Additional accessories.
 - 11. Automatic transfer switch (ATS).
 - 12. Access platform and stairs.
- B. Types of generator sets required include:
 - 1. Permanent Diesel Engine-driven Generator.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013400, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data on diesel engine-driven generator sets and components.
 - a. Generator dimensions.
 - b. Generator weight.
 - c. Generator rating.
 - d. Alternator rating.
 - e. Generator Starting System Data:
 - 1) Battery size and ratings.
 - 2) Charging system capacity.
 - 3) Battery heater data.
 - 4) Battery warranty.
 - f. Generator Control Panel Data:
 - 1) Layout.
 - 2) Wiring diagrams.
 - 3) Control interconnection.
 - 4) Instrumentation.
 - g. Exhaust System Data:
 - 1) Muffler size.
 - 2) Decibel reduction curve.

- 3) Fuel system data.
- h. Cooling System Data:
 - 1) Radiator capacity.
 - 2) Cooling reduction capacity
- i. Enclosure Data:
 - 1) Materials.
 - 2) Size.
 - 3) Assembly/disassembly instructions.
 - 4) Door locations.
 - 5) Noise reduction.
 - 6) Color.
- j. Sub-Base Fuel Tank:
 - 1) Capacity.
 - 2) Fuel usage calculations.
 - 3) Coating.
- k. ATS Data:
 - 1) Enclosure Material.
 - 2) Dimensions.
 - 3) Factory test report.
- l. Warranty data.
- m. Accessory and miscellaneous equipment.
- 2. Wiring Diagrams: Submit wiring diagrams for diesel engine-driven generator units showing connections to electrical power panels, feeders, and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.
- 3. Agreement to Maintain: Prior to time of final acceptance, Installer shall submit 4 copies of an agreement for continued service and maintenance of diesel engine-driven generator sets for OWNER's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for 1-year period with option for renewal of Agreement by OWNER.
- 4. Certifications: Provide diesel engine-driven generator sets certified test record of the following final production testing:
 - a. Single-step load pickup.
 - b. Transient and steady-state governing.
 - c. Safety shutdown device testing.
 - d. Voltage regulation.
 - e. Rated power.
 - f. Maximum power.
 - g. Provide certified test record prior to engine-driven generator set being shipped from factory to Project location.
- 5. Spare Parts Data: Submit a list of spare parts for the equipment specified.
- 6. Operating and Maintenance Instruction Manuals:
 - a. Operating instruction manuals outlining step-by-step procedures required for system startup and operation.
 - b. Manufacturer's name, model number, service manual parts list.
 - c. Brief description of equipment and basic operating features.
 - d. Maintenance instruction manuals outlining maintenance procedures.

- e. Troubleshooting guide listing possible breakdown and repairs.
- f. Point-to-point connection wiring diagram for the system.
- g. Performance Test Reports: Upon completion of installed system, submit in booklet form all shop and field tests performed to prove compliance with specified performance criteria.
- h. Provide OWNER with two (2) electronic copies of O&M manuals on CD's.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

- 1. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines," NFPA 99, "Standard for Health Care Facilities," and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures."
- 2. UL Compliance: UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," UL 2200, "Standard for Safety for Stationary Engine Generator Assemblies," rated 600 volts or less. UL 1008, "Automatic Transfer Switches," and UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide transfer switches and components which are UL listed and labeled.
- 3. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NE MA MG1, "Motors and Generators," and MG2, "Safety and Use of Electric Motors and Generators." NEMA Standards Pub/Nos. ICS 2, "Industrial Control Devices, Controllers and Assemblies," ICS 6 and 250, pertaining to transfer switches.
- 4. IEEE Compliance: Comply with applicable portions of IEEE Standard 446, "IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications."

B. Submittal information shall be generated from a representative located within Collier County who has knowledge of Local and State code requirements.

C. Warranty: Submit in accordance with requirements of Section 01740, warranties covering the items included under this Section. Unit shall be provided with a full comprehensive warranty of 5 years or 1500 running hours from date of ENGINEER's acceptance. Response time shall be a maximum of 3 hours. Provide label on inside of generator with description of warranty period and contact information.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Manufactured material shall be adequately packed to prevent damage during shipping, handling, storage and erection. Material shipped to site shall have approval of OWNER prior to shipping. All shipped material shall be packed in a container properly marked for identification. Blocks and padding shall be used to prevent movement.
- B. CONTRACTOR shall inspect the material prior to removing it from carrier. If damage is observed, CONTRACTOR shall immediately notify carrier so that a claim can be made. If no such notice is given, material shall be assumed to be in undamaged condition, any subsequent damage that occurs to the equipment shall be the responsibility of CONTRACTOR.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Standby Diesel Generator Sets:
 - a. Caterpillar.
 - b. Cummins.
 - 2. Automatic Transfer Switches:
 - a. Caterpillar.
 - b. Cummins

2.02 GENERATOR SETS

- A. Except as otherwise indicated, provide manufacturer's standard diesel engine-driven generator set and auxiliary equipment as indicated by published product information, and as required for a complete installation. Generator set shall be rated to continuously power the total accumulated load and starting load shown on Schedule at 100 degrees F ambient temperature and at altitude where installed.
- B. Diesel Engine: Provide a 4-cycle, compression ignition type engine for operation on a commercial grade of petroleum fuel oil such as No. 2 fuel oil. Engine operating speed shall not exceed 1,800 rpm and shall be controlled by a governor to maintain alternator frequency within plus or minus 3 Hertz of 60 hertz from no load to full load. Frequency shall recover to steady-state tolerance within 5 seconds after application of 90 percent rated load.
- C. Starting System: Provide engine-generator unit with 12- or 24-volt, negative ground, starting system including positive engagement solenoid shift-starting motor, batteries, and 35-ampere, or greater, automatic battery charging alternator with solid-state voltage regulator. Mount batteries in a plastic- or epoxy-coated metal platform near the starter but not on the generator and coat battery terminals with an anti-oxidant. Generator sets rated 150 kW or less shall have a battery rated 650 amperes cold cranking at 0 degree F and 170 minutes reserve capacity by SAE Standard J-537. Larger generators shall have a battery rated either 220 ampere-hours or 900 amperes cold cranking, and 430 minutes reserve capacity. Batteries shall have a 12-month full warranty and 60-month prorated warranty.
- D. Battery Charger: Provide a solid-state, current limiting, float-type SENS model #NRG22-10-RC battery charger with 10-ampere minimum capacity. Charger shall operate from 120-volt AC single phase, 60 hertz power and shall automatically keep batteries at full charge. Equip charger with ammeter and voltmeter. Battery charger shall be located within the generator enclosure.
- E. Alternator: Provide a single bearing brushless, self-excited alternator with inherently regulated rotating rectifier exciter system or a revolving field design with a temperature compensated solid-state voltage regulator. Connect the alternator housing directly to the

engine flywheel housing. Couple the alternator rotor directly to engine flywheel with a semi-flexible steel disk coupling.

1. Provide windings with Class F insulation with epoxy impregnation and fungus-resistant coating. Temperature rise shall be as defined in NEMA Standard MG1-22.40.
 2. The alternator shall be capable of starting load given for site with 35 percent maximum instantaneous voltage dip. Instantaneous voltage dip shall only be 20 percent when there is a VFD. Recovery to stable equation within plus or minus 5 percent of rated voltage shall occur within 3 seconds.
- F. Engine Cooling Radiator: Provide a complete engine cooling system equipped with a radiator and blower type fan sized to maintain safe operation, 190 degrees F engine outlet water temperature at 100 degrees F maximum ambient temperature. The engine cooling system shall be filled with a solution of 50 percent ethylene glycol.
- G. Instrument Control Panel: Provide engine-generator unit with engine oil-pressure and water-temperature indicators, reset circuit breaker, static voltage regulator, voltage-adjusting rheostat, voltmeter, ammeter with phase selector switch with an OFF position, and with running time indicator and frequency meters. Select circuitry of plug-in design capable of quick replacement, and capable of accepting a plug-in device which allows maintenance to test control panel performance without operating the engine.
1. Provide a cranking limiter to open starting circuit in 45 to 90 seconds if engine has not started within that time or after a series of 3 or more cranking intervals separated by 2 or more rest periods.
 2. Provide engine safety devices to shut unit down on high engine temperature, low oil pressure, overspeed, and overcrank. Provide, for each of these conditions, an alarm light and an unpowered, normally open contact for remote use. Provide an audible alarm with silence switch which is activated by any alarm condition. Provide additional unpowered, normally open contact for remote use that indicates general generator alarm. General alarm contact will be for any alarms associated with the generator and not pre-assigned to a specific alarm. Sacrificing a specific alarm in order to receive the general alarm contact is not acceptable.
 3. Provide a relay with 2 normally open and 2 normally closed contacts rated 5A at 120 volts AC and which is energized when unit is running. Wire these contacts to terminal strips for remote use.
 4. Provide a RUN-OFF-AUTO switch. In AUTO position unit shall start when a remote contact closes and stop when contact opens. In RUN position unit shall start and run until OFF position is selected.
 5. Mount instrument control panel on unit such that it is isolated from generator set vibration.

2.03 PERMANENT ENGINE-GENERATOR SET ACCESSORIES

- A. Enclosure Design: Generator set shall be provided with a skin tight outdoor enclosure. Enclosure roof and side panels shall be constructed from a minimum of 0.090 Marine Grade Aluminum. Side panels shall be constructed from a minimum of 0.090 Marine Grade Aluminum. The Side Walls shall be complete with necessary access doors and ventilating louvers. There shall be at least 2 access doors on each side of enclosure and

one at the generator control panel for access to the controls. Doors shall be capable of full-range of motion. CONTRACTOR shall coordinate final location of generator to accommodate door swings. Any changes due to generator clearances shall be at the expense of the CONTRACTOR. Doors shall be hung on full-length piano hinge assembly. All hinge hardware shall be stainless steel. Finish paint shall be powder-coated over epoxy primer. Doors shall be equipped with handles. Louvers shall be stationary type and shall be arranged to provide adequate protection against rainfall at 15 degrees from vertical. Air of intake louvers shall be sized so not to exceed .5 inches of water column while providing the required genset cooling and combustion air flow. Enclosure shall be of bolted formed panel type construction. Exhaust shall be provided within the enclosure unless otherwise directed by the ENGINEER. Roof shall have sufficient strength to support an exhaust silencer. Enclosure shall be large enough to fully enclose all components necessary to the system. All doors shall be capable of being locked or have provisions for padlocks. Door hardware shall be stainless steel.

1. All raceway and conduits within the enclosure shall be sealed-tight flexible conduit or rigid aluminum or galvanized steel with malleable iron boxes and compression type fittings as appropriate for the raceways used under NEC. EMT and flex or "Greenfield" conduits are not acceptable.
 2. When this outdoor enclosure is specified, the temperature specifications for unit shall be 0 degrees F to 120 degrees F with ambient air at radiator intake being 100 degrees F maximum.
 3. Modular enclosures shall comply with DCA, Florida Building Code and have a minimum sustained wind rating of 150 MPH.
 4. The CONTRACTOR is responsible for verifying the impact rating requirements under Florida Building Code and shall provide a generator enclosure in compliance to these standards.
 5. Consult the ENGINEER prior to bid when generator is located within any "Zone 4 impact area under FBC".
 6. Enclosure shall match footprint of sub base fuel tank.
- B. Sound Attenuation: Enclosure shall be insulated to attenuate sound and include sound attenuating features that direct radiant cooling air in a route to minimize ambient noise when generator is running.
- C. Operational noise shall not exceed 75 dBA at 23 feet (in Free Field Conditions). Additional sound attenuation references or limitations may be required. See drawings for additional details. If generator is located within 50 feet of a commercial or residential unit, then operational noise shall not exceed 55 dBA.
- D. Source dBA and sound attenuation shall be as measured and defined under ANSI S12.34-1998 and SIO 3744 as applicable. Additional local codes and standards may apply for generator operational noise. The CONTRACTOR is responsible for compliance to all local standards without change order or additional payment.
- E. Fuel System: Provide unit with a UL142 compliant double-wall skid base type integral fuel tank that is "skid" mounted, unless otherwise directed by the ENGINEER's drawings or addenda. Tank capacity shall be a maximum of 550 gross volume gallons. The

tank capacity shall be calculated assuming the tank is 90% full and based on the generator running at full load/speed continuously for three (3) days.

- F. The ENGINEER has projected fuel use estimates using equipment listed as the basis of design. The CONTRACTOR is responsible for providing the manufacturer's fuel usage calculations with submittal documents for ENGINEER's review.
- G. The fuel tank shall be furnished with UL142 and FDEP required accessories to include a fuel site gauge, normal and emergency vents and fuel cap having padlocking provisions. All necessary fuel supply and return line shall be furnished pre-assembled to unit. The Fuel Tank shall meet all applicable State and local standards for the volume of fuel the tank will hold.
- H. Sub base fuel tank size shall be provided and sized as shown on the contract documents and within the specifications.
- I. Sub base fuel tank shall not allow pooling or ponding of water on top once generator is mounted on top.
- J. Tank shall be made by a manufacturer with minimum of (10) ten years' experience in the design and construction of UL Listed, FDEP and NFPA compliant sub base fuel tanks. Manufacturer of the fuel tank must be approved and registered with the State of Florida, and have their required "EQ" file number on the supplied fuel tank. The installing CONTRACTOR is responsible for supplying fuel for the field testing.
- K. The fuel tank shall be mounted under the generator skid rails, consisting of a dual wall design constructed to UL142 and standards applicable to this application under FS-62-762, NFPA 30, NFPA 37 and NFPA 110. All fuel tanks shall comply with the requirements set forth by Collier County Pollution Control.
- L. Sub base fuel tank shall be rectangular in shape and include reinforced steel box channel for generator support.
- M. Both the inner and outer tanks shall be constructed of 304 stainless steel.
- N. The outer wall shall be prepared before & after primer. Prime with one coat of epoxy primer to a thickness of 12-15 mils (DFT). Outer wall finish coat shall be a high gloss, black, UV blocking epoxy primer applied to a minimum thickness of 3.5 mils (DFT). All welds and fasteners connecting the generator skid base to the fuel tank shall be similarly primed and finished. Primers shall not be electrostatically or powder applied. Primers shall be hand applied & dried in a drying booth.
- O. Fuel tank shall be equipped with a magnetic liquid level fuel gauge as manufactured by Rochester Gauges, Inc. Fuel tank level shall be output as a 4-20mA signal from the generator control panel.

- P. Sub base fuel tank shall have a 4 point lifting system in place when shipped to the site. It shall be the responsibility of the Generator manufacturer to recommend a lifting system along with instructions for the CONTRACTOR on site.
- Q. Sub base tank testing shall consist of primary and secondary tank containment basin and shall be pressurized at 3-5 psi and leak checked to ensure integrity of sub base weld seams per UL-142 standards. A copy of this report shall accompany close-out documents. Fuel containment basin shall be sized as a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture. Provide a fuel containment basin leak detector switch.
- R. The sub base tank fittings shall include the following:
1. Appropriately sized NPT fuel supply.
 2. Fuel return fitting
 3. 2" NPT for normal vent
 4. NPT for emergency vent, sized as appropriate
 5. 2" NPT for manual fill.
 6. NPT for level gauge, sized as appropriate.
 7. 3/8" NPT basin drain
 8. 2" NPT for level alarm.
 9. NPT fitting for leak detection alarm
- S. Coolant Heater: Provide engine coolant heater that operates from 120-volt AC single phase, 60 hertz power with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements of NFPA 99.
- T. Inlet and Exhaust Systems: Silencers and exhaust ducting to silencers shall be self-supporting when assembled. Provide all necessary supporting members for ductwork between silencer and outlet. Provide all required cutting as shown on Drawings and noted herein. The unit shall be complete with raincap. All exhaust duct shall be Schedule 10 steel pipe, minimum. Inlet silencer and filter to be self-supporting. Provide necessary supports for all intake ductwork. All intake ducts shall be Schedule 10 steel pipe, minimum.
1. Provide a silencer which meets sound standards of a critical area. Silencer shall provide attenuation (input to output) of 25 dB or greater at frequencies of 125 hertz to 8 kilohertz. A curve shall be submitted with Shop Drawings showing attenuation (input to output) in dB versus frequency. Curve shall be on manufacturer's standard data sheet or from an independent test lab. A spiral or bellows-type flexible section of pipe shall be installed in the exhaust line between the muffler and engine manifold connection. An insulated thimble section shall be provided where exhaust line passes through roof or wall. Exhaust lines shall be pitched and a condensation trap provided at non-draining low points in line.
- U. Circuit Breaker: A generator power circuit breaker shall be installed as a manual load circuit interrupter and an automatic overload and short circuit protection device.
1. The circuit breaker shall be a solid-state trip type for all sizes rated 200 amps continuous and larger. Solid-state trip shall include Long-time, Short-time, and Instantaneous. Ground fault trip required on breakers 1,000 amps and above.

2. 100% ratings under UL shall be required as noted on ENGINEER's drawings.
3. AIC rating for generator power circuit breaker shall meet or exceed that of the upstream service entrance rating.
4. Generator power circuit breaker shall be UL listed as short circuit, service entrance rated device under UL and NEC.
5. Trip settings for all breakers shall be selected for the rating of the generator power circuit as indicated on Drawings.
6. Provide breaker and alternator trip curves in the submittal. Show coordination of curves for equipment provided.

V. Provide protective relays to protect the generator system/alternator.

W. Alternator protection equipment as basis of design shall be equal to "Amp Sentry" protection by Cummins Power Generation with the following features: Over current and short-circuit shut down - Over current warning -Single and three phase fault regulation - Over and under voltage shut down - *Over and under frequency shut down* - *Overload warning with alarm contact* - *Reverse power and reverse Var shut down* - Excitation fault. Equipment other than basis of design is subject to ENGINEER's approval. Provide full submittal and comparison data for ENGINEER's review on equipment as provided.

X. Any pump station requiring a generator shall also have a generator receptacle located on the pump control panel for a portable generator, coordinate exact model with OWNER.

2.04 AUTOMATIC TRANSFER SWITCHES

- A. Automatic Transfer Switch: UL listed and 600 volt-rated with amperage rating shown on Drawings and shall be the mechanically held, electrically operated type rated for continuous duty in an unventilated sheet metal enclosure.
- B. Switch shall be double throw, with an off position, having electrical operated normal-emergency positions inherently interlocked mechanically, and with main contacts mechanically attached to a common shaft. Main contacts shall be silver alloy wiping-action type. They shall be protected by arcing contacts.
- C. Heavy duty emergency pushbuttons shall be provided. Emergency pushbuttons shall reset when pulled out.
- D. Switch and Relay Contacts, Coils, Springs, and Control Elements: Removable from front of transfer switch without removal of the switch panels from enclosure and without disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous duty industrial control type with 600 volt, 10 amp rated contacts.
- E. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system

to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.

- F. Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
- G. Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.
- H. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
- I. Upon drop in normal voltage of 83-85 percent of rated voltage, and after an override delay of 3 seconds nominal, switch shall start generator and transfer the load to emergency source, provided emergency source voltage and frequency are 90 percent of rated or higher.
- J. Upon return of normal source voltage for 5 seconds nominal, to 92-95 percent of rated, switch shall retransfer load to normal source after a minimum transfer time or if emergency source fails. Provide a 5- to 60-second adjustable time delay to maintain transfer switch in the "Off" position during transfer to either source.
- K. Sensing relays shall operate without contact chatter or false response when voltage is slowly varied to dropout and pickup levels.
- L. Four auxiliary contacts shall be provided: Two for transfer switch position indicating use, and two auxiliary contacts, one N.O. and one N.C. to operate after completion of the 3-second override delay for starting generator. All auxiliary contacts shall be 600 volt, 10 amp continuous rating.
- M. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities:
 - 1. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control
 - 2. High intensity LED lamps to indicate that the transfer switch is "not in auto" (due to control being disabled or due to bypass switch (when used) enabled or in operation) and "Test/Exercise Active" to indicate that the control system is testing or exercising the generator set.
 - 3. "OVERRIDE" pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.

4. "TEST" pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
5. "RESET/LAMP TEST" pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
6. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool and an operator display panel.
7. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
 - a. Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance. Line to neutral voltages shall be displayed for 4-wire systems.
 - b. Display source status, to indicate source is connected or not connected.
 - c. Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
 - d. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - 1) Set nominal voltage and frequency for the transfer switch.
 - 2) Adjust voltage and frequency sensor operation set points.
 - 3) Set up time clock functions.
 - 4) Set up load sequence functions.
 - 5) Enable or disable control functions in the transfer switch, including program transition.
 - 6) Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
 - e. Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
 - f. Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
 - g. Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, and network communications error.
- N. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal

voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.

- O. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 - 1. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
 - 2. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
 - 3. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
- P. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).
- Q. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
- R. The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +70C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
- S. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
- T. Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70. The cabinet door shall include permanently mounted key type latches.
- U. Transfer switch equipment shall be provided in a NEMA 4X enclosure.
- V. The enclosure shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.
- W. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal

position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.

- X. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 2. The transfer switch shall issue a compatible start command to the generator set, and cause the generator set to start and run at idle until it has reached normal operating temperature.
 3. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
 4. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 5. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 6. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 7. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.
- Y. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:
1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 2. The transfer switch shall issue a compatible start command to the generator set, and cause the generator set to start and run at idle until it has reached normal operating temperature.
 3. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
 4. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
 5. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

- Z. Factory Testing. The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be provided to OWNER & ENGINEER upon delivery of generator. Test process shall include calibration of voltage sensors.
- AA. The manufacturer of the transfer switch and generator set shall maintain service parts inventory at a central location (within 50 miles of the city) which is accessible to the service location 24 hours per day, 365 days.
- BB. The transfer switch shall be serviced by a local service organization that is trained and factory certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- CC. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.
- DD. Accessory devices shall be provided as follows:
 - 1. Time delay to override harmless power dips and outages. (Inverse time characteristic with voltage.)
 - 2. Test switch.
 - 3. Auxiliary contacts (as specified herein).
 - 4. Selector relay (as specified herein).
 - 5. Lockout relay (sensitive to voltage and frequency).
 - 6. Full phase protection with nominal 75-80 percent dropout and 92-95 percent pickup on phase relay.
 - 7. Adjustable time delay on retransfer to normal source. Minimum retransfer of 2 minutes and maximum of 25 minutes. Built-in circuitry to nullify the retransfer time delay if the emergency source fails and the normal source is available.
 - 8. Adjustable (10-20 minutes) time delay for running generator unloaded after transfer for cool down.
 - 9. Adjustable time delay or delays (5 to 60 seconds) for holding transfer switch in the "Off" position when switching from standby source to normal and normal source to standby.
 - 10. Engine starting contact.
 - 11. A selector switch shall permit generator to be exercised with or without load.

2.05 ACCESS PLATFORM

- A. Elevated platforms shall be provided where necessary to provide access to the generator for operation and maintenance. Typically, these platforms shall be limited to locations with existing grades requiring equipment to be located at a higher elevation due to the Florida Building Code (FBC), FEMA, and the ASCE Standard 7 and 24 requirements.
- B. Platforms and stairs shall meet the Occupational Safety and Health Administration (OSHA) Part 1910, applicable FBC requirements, and ASCE Standards 7 and 24. All platform and stair designs and plans shall be prepared by a Florida Registered

Professional Engineer. The Engineer of Record shall identify Flood Hazard Area, Flood Design Class (ASCE 24) and other applicable loadings. All components shall be aluminum with stainless steel hardware. Standard stairs shall be utilized. Fall protection shall be provided on all exposed sides by use of an OSHA approved guardrail system. Where required for access, removable guardrail sections shall be provided. Grating shall be slip resistant and banded at ends of bearing bars and openings.

- C. All platforms and stairs shall be supported by a concrete foundation system. The foundation designs and plans shall be prepared by a Florida Registered Professional Engineer. It shall meet the requirements of the FBC, ASCE 7 (Dead, Live, Flood, and Wind), ASCE 24 (Flood Resistant) and other regulatory requirements. Where head clearance under the platform is less than 6'-8", provisions shall be made to limit access.

PART 3 EXECUTION

3.01 INSTALLATION OF DIESEL ENGINE-DRIVEN GENERATOR SETS

- A. Install diesel engine-driven generator units as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.
- B. Coordinate with other work, including raceways, electrical boxes and fittings, fuel tanks, piping, and accessories, as necessary to interface installation of engine generator equipment work with other work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.
- D. Install units on steel spring type vibration isolators fastened to an inertia base in accordance with manufacturer's instructions.
- E. Connect fuel piping to generator equipment as indicated, and comply with manufacturer's installation instructions.

3.02 GROUNDING

- A. Provide equipment grounding connections for diesel engine-driven generator unit and automatic transfer switch as indicated. Connect generator equipment ground to ground ring around generator pad. Ground ring shall have a minimum of four (4) 5/8" x 20' copper-clad ground rods. Connect ground ring to sites counterpoise. Connections to ground ring, counterpoise and ground rods shall be exothermically welded. Add additional ground rings as required to meet five (5) ohm (or less) specified resistance. Tighten connections to comply with tightening torques specified in UL Standard 486A to ensure permanent and effective grounding.

3.03 FIELD QUALITY CONTROL

A. Start-up Testing:

1. Engage local equipment manufacturer's representative to perform start-up and building load tests upon completion of installation, with ENGINEER in attendance; provide certified test record. Tests are to include the following:
 - a. Check fuel, lubricating oil, and antifreeze in liquid-cooled models for conformity to manufacturer's recommendations under environmental conditions present.
 - b. Test prior to cranking engine for proper operation, accessories that normally function while the set is in a standby mode. Accessories include: alternator strip heater, engine coolant heater, and battery charger.
 - c. Check, during start-up test mode, for exhaust leaks, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage, and phase rotation.
 - d. Test, by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shutdown. Prior to this test, adjust for proper system coordination, transfer switch timers. After installation inspection and fine adjustments have been completed, the Generator set shall be connected to resistive type load banks, matching the full rated output of this installed generator set.
- 1) A four (4) hour 100% resistive load bank test, matching the full rated output of this installed generator set, is to be performed after installation in the presence of the ENGINEER, OWNER, and any required Authority. Coordinate with ENGINEER, OWNER, and any required Authority for appropriate test date and time. During this load bank test, monitor the engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency. Voltage dip will be observed with a recording oscilloscope furnished by supplier for this test only. Voltage dip is defined as the peak-to-peak voltage minimum, at starting compared to the average peak-to-peak voltage with the starting load running. The difference shall be less than 25 percent of the running P-P voltage.
- 2) Provide a test of safeties and transfer under NFPA-110 criteria.
- 3) Provide all tests in the presence of an OWNER representative.
Upon completion of installation and testing, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to OWNER.

3.04 QUALITY ASSURANCE

- A. Commissioning and Qualifications shall be performed by Manufacturer's authorized and factory certified trained for installation of units personnel.
- B. Maintenance Proximity: The commissioning and selling manufacturer office location shall not be more than two hours' normal travel time from the project site.
- C. Access to Service & Parts: Manufacturer for the Generator shall maintain a full

operational facility, with service, parts and distribution center within 50 miles of the Project Site. A 'sales office' will not qualify as a service & parts facility. A "dealer" that buys product from a Factory Distributor does not qualify.

- D. Manufacturer's Qualifications: The manufacturer shall be in the business of manufacturing power generation systems under ISO-9001 certification process for over 10 years. The manufacturer shall employ service, engineering, and parts staff within a factory-owned or authorized service center, within 50 miles of Project site.
- E. When an "upfitter" is used for a fuel tank or generator enclosure, the manufacturer shall be located in the same state as the Project Site.
- F. Upfitters shall provide their UL Listing number on all documentation of compliance. UL as an "assembly" under the generator manufacturer's main UL Listing is not acceptable.
- G. cUL (or other) listing or compliance shall not be accepted in lieu of UL listing and label.
- H. Manufacturer Service Qualifications: The generator manufacturer shall have a service center within a 2-hour driving distance from the project site. This service center shall have engineering, application support, on-site rental, start-up, commissioning, and replacement parts and labor for the maintenance and repair of the same brand of power generation system equipment as supplied on the Project.
- I. Source Limitations: Obtain all equipment under this section through one source as practical and possible under the limitations of the manufacturer's ability to provide equipment.
- J. The equipment under this Section must be sold to the installer or the OWNER by an entity operating from within the project State.
- K. The equipment under this Section must be installed by a CONTRACTOR operating from offices located within the Project state.
- L. Equipment under this section shall be provided by a single manufacturer, so as to provide only one source of warranty and responsibility whenever possible.
- M. Generator engine, alternator, and generator controller shall be provided by a single manufacturer exceptions must be noted in submittal. The ENGINEER reserves the right to reject exceptions based on the equipment used as the basis of design in comparison.

3.05 PERSONNEL TRAINING

- A. Building Operating Personnel Training: Train OWNER's building personnel in procedures for starting-up, testing, and operating diesel engine-driven generator sets. In addition, train OWNER's personnel in periodic maintenance of batteries.

END OF SECTION

SECTION 312316
EXCAVATION - EARTH AND ROCK

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for performing opencut excavations to the widths and depths necessary for constructing structures and pipelines, including excavation of any material necessary for any purpose pertinent to the construction of the Work.
- B. Related Work Specified In Other Sections Includes:
 - 1. Section 017416 – Site Clearing
 - 2. Section 033100 – Concrete, Masonry, Mortar and Grout
 - 3. Section 312319 – Groundwater Control for Open Cut Excavation
 - 4. Section 312323 – Backfilling
 - 5. Section 314000 – Shoring, Sheet piling and Bracing

1.2 DEFINITIONS

- A. Earth: "Earth" includes all materials which, in the opinion of the ENGINEER, do not require blasting, barring, wedging or special impact tools for their removal from their original beds, and removal of which can be completed using standard excavating equipment. Specifically excluded are all ledge and bedrock and boulders or pieces of masonry larger than one cubic yard in volume.
- B. Rock: "Rock" includes all materials which, in the opinion of the ENGINEER, require blasting, barring, wedging and/or special impact tools such as jack hammers, sledges, chisels, or similar devices specifically designed for use in cutting or breaking rock for removal from their original beds and which have compressive strengths in their natural undisturbed state in excess of 300 psi. Boulders or masonry larger than one cubic yard in volume are classed as rock excavation.

1.3 SUBMITTALS

- A. General: Provide all submittals, including the following, as specified in Division 1.

- B. Engage the services of a Professional Engineer who is registered in the State of Florida to design all cofferdam and sheeting and bracing systems which the CONTRACTOR feels necessary for the execution of his work. Submit to the ENGINEER a signed statement that he has been employed by the CONTRACTOR to design all sheeting and bracing systems. After the systems have been installed, furnish to the ENGINEER an additional signed statement that the cofferdams and sheeting and bracing systems have been installed in accordance with his design.
- C. If a detour is required, submit a traffic control plan for approval to County Manager or designee and/or the Florida Department of Transportation as described in Section 015526.

1.4 SITE CONDITIONS

- A. Geotechnical Investigation: A geotechnical investigation may have been prepared by the COUNTY and ENGINEER in preparing the Contract Documents.
 - 1. The geotechnical investigation report may be examined for what ever value it may be considered to be worth. However, this information is not guaranteed as to its accuracy or completeness.
 - 2. The geotechnical investigation report is not part of the Contract Documents.
- B. Actual Conditions: Make any geotechnical investigations deemed necessary to determine actual site conditions.
- C. Underground Utilities and Collier County Damage Prevention Policy:
 - 1. This policy has been put in place to avoid damage to Collier County underground utilities. A minimum distance of five feet (5') horizontally and eighteen inches (18") vertically must be maintained away from Collier County utilities. Any and all variations from this order must be the Water or Wastewater Department.
 - 2. Before commencement of any excavation at road crossings or any boring or any drilling, the contractor shall mark the proposed run alignment with white paint or flags. Subsequent to placement of the white markings, the existing underground utilities in the area affected by the work must be marked by Sunshine One Call after proper notification to them by either calling 811 in Florida or toll free at 1-800-432-4770. Visit www.sunshine811.com for more information. Before commencing excavation for the work, potholing of all potential conflicts must be performed.
 - 3. All lines in conflict must be physically located by the contractor. Any conflict shall be reported to the utility and Collier County Public Utilities. Utilities under concrete or pavement may require soft dig vacuum locates which also is the contractor's responsibility to perform. All utilities will be field marked per Sunshine State One Call's statutes and guidelines. For line verification or any

other information concerning locates, please call the Locate Department at 239-252-5922 during normal business hours. For line verification or emergency locates after hours, call emergency number 239-825-1444. **In the event the potholing and/or vacuum soft dig does not locate the marked utility, work must be stopped and the affected utility owner contacted.** Failure to comply with this policy and obtain required signature(s) may result in revocation of existing right-of-way permits.

4. The contractor must comply with all provisions of Florida Statute 556, the Underground Facility Damage Prevention and Safety Act.
- D. Quality and Quantity: Make any other investigations and determinations necessary to determine the quality and quantities of earth and rock and the methods to be used to excavate these materials.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL

- A. Clearing: Clear opencut excavation sites of obstructions preparatory to excavation. Clearing in accordance with Section 017416, includes removal and disposal of vegetation, trees, stumps, roots and bushes, except those specified to be protected during trench excavation.
- B. Banks: Shore or slope banks to the angle of repose to prevent slides or cave-ins in accordance with Section 314000.
- C. Safety: Whenever an excavation site or trench is left unattended by the CONTRACTOR or when an area is not within 100 feet of observation by the CONTRACTOR, the excavation site or trench shall be filled and/or, at the County's Manager or designee discretion, protected by other means to prevent accidental or unauthorized entry. Include barricades and other protection devices requested by the ENGINEER or County Manager or designee, including temporary fencing, snow fencing, or temporary "structure" tape. Such safety items shall not relieve the CONTRACTOR of any site safety requirements or liabilities established by Federal, State and local laws and agencies, including OSHA, but is intended as additional safety measures to protect the general public.
- D. Hazardous Materials: If encountered, take care of hazardous materials not specifically shown or noted in accordance with Section 015000.

- E. During excavation and any site work, take storm water pollution prevention measures to ensure that water quality criteria are not violated in the receiving water body and all state and local regulatory requirements are met.

3.2 STRUCTURE EXCAVATION

- A. Excavation Size: Provide excavations of sufficient size and only of sufficient size to permit the Work to be economically and properly constructed in the manner and of the size specified.
- B. Excavation Shape: Shape and dimension the bottom of the excavation in earth or rock to the shape and dimensions of the underside of the structure or drainage blanket wherever the nature of the excavated material permits.
- C. Compaction: Before placing foundation slabs, footings or backfill, proof roll the bottom of the excavations to detect soft spots.
 - 1. For accessible areas, proof roll with a ten wheel tandem axle dump truck loaded to at least 15 tons or similarly loaded construction equipment.
 - 2. For small areas, proof roll with a smooth-faced steel roller filled with water or sand, or compact with a mechanical tamper.
 - 3. Make one complete coverage, with overlap, of the area.
 - 4. Overexcavate soft zones and replace with compacted select fill.

3.3 TRENCH EXCAVATION

- A. Preparation: Properly brace and protect trees, shrubs, poles and other structures which are to be preserved. Unless shown or specified otherwise, preserve all trees and large shrubs. Hold damage to the root structure to a minimum. Small shrubs may be preserved or replaced with equivalent specimens.
- B. Adequate Space: Keep the width of trenches to a minimum, however provide adequate space for workers to place, joint and backfill the pipe properly.
 - 1. The minimum width of the trench shall be equal to at least 3.5 feet or the outside diameter of the pipe at the joint plus 8-inches for unsheeted trench or 12 inches for sheeted trench, whichever is greater. Conform the trench walls to OSHA Regulations.
 - 2. In sheeted trenches, measure the clear width of the trench at the level of the top of the pipe to the inside of the sheeting.
- C. Depth:

1. Excavate trenches to a minimum depth of 8 inches, but not more than 12 inches, below the bottom of the pipe so that bedding material can be placed in the bottom of the trench and shaped to provide a continuous, firm bearing for pipe barrels and bells.
 2. Standard trench grade shall be defined as the bottom surface of the utility to be constructed or placed within the trench. Trench grade for utilities in rock or other non-cushioning material shall be defined as additional undercuts backfilled with crushed stone compacted in 6-inch lifts, below the standard 8-inches minimum trench undercut. Backfill excavation below trench grade not ordered in writing by the ENGINEER with acceptable Class I, II or III embedment material to trench grade and compact to density equal to native soil.
- D. Unstable or Unsuitable Materials: If unstable or unsuitable material is exposed at the level of the bottom of the trench excavation, excavate the material in accordance with the subsection headed "Authorized Additional Excavation".
1. Remove material for the full width of the trench and to the depth required to reach suitable foundation material.
 2. When in the judgment of the ENGINEER the unstable or unsuitable material extends to an excessive depth, the ENGINEER may advise, in writing, the need for stabilization of the trench bottom with additional select fill material, crushed stone, washed shell, gravel mat or the need to provide firm support for the pipe or electrical duct by other suitable methods.
 3. Crushed stone, washed shell and gravel shall be as specified in Section 312323.
 4. Payment for such trench stabilization will be made under the appropriate Contract Items or where no such items exist, as a change in the Work.
- E. Length of Excavation: Keep the open excavated trench preceding the pipe laying operation and the unfilled trench, with pipe in place, to a minimum length which causes the least disturbance. Provide ladders for a means of exit from the trench as required by applicable safety and health regulations.
- F. Excavated Material: Neatly deposit excavated material to be used for backfill at the sides of the trenches where space is available. Where stockpiling of excavated material is required, obtain the sites to be used and maintain operations to provide for natural drainage and not present an unsightly appearance.
- G. Water: Allow no water to rise in the trench excavation until sufficient backfill has been placed to prevent pipe flotation. Provide trench dewatering in accordance with Section 312319.

3.4 EXCAVATION FOR JACKING AND AUGERING

- A. Jacking and Augering Requirements: Allow adequate length in jacking pits to provide room for the jacking frame, the jacking head, the reaction blocks, the jacks, auger rig, and the jacking pipe. Provide sufficient pit width to allow ample working space on each side of the jacking frame. Allow sufficient pit depth such that the invert of the pipe, when placed on the guide frame, will be at the elevation desired for the completed line. Tightly sheet the pit and keep it dry at all times.

3.5 ROCK EXCAVATION

- A. Rock Excavation: Excavate rock within the boundary lines and grades as shown, specified or required.
 - 1. Rock removed from the excavation becomes the property of the CONTRACTOR. Transport and dispose of excavated rock at an off site disposal location. Obtain the off site disposal location.
 - 2. Remove all shattered rock and loose pieces.
- B. Structure Depths: For cast-in-place structures, excavate the rock only to the bottom of the structure, foundation slab, or drainage blanket.
- C. Trench Width: Maintain a minimum clear width of the trench at the level of the top of the pipe of the outside diameter of the pipe barrel plus 2 feet, unless otherwise approved.
- D. Trench Depth: For trench excavation, in which pipelines are to be placed, excavate the rock to a minimum depth of 8 inches below the bottom of the pipe or duct encasement. Provide a cushion of sand or suitable crushed rock. Refill the excavated space with pipe bedding material in accordance with Section 312323. Include placing, compacting and shaping pipe bedding material in the appropriate Contract Items.
- E. Manhole Depths: For manhole excavation, excavate the rock to a minimum depth of 8 inches below the bottom of the manhole base for pipelines 24 inches in diameter and larger and 6 inches below the bottom manhole base for pipelines less than 24 inches in diameter. Refill the excavated space with pipe bedding material in accordance with Section 312323. Include placing, compacting and shaping pipe bedding material for manhole bases in the appropriate Contract Items.
- F. Over-excavated Space: Refill the excavated space in rock below structures, pipelines, conduits and manholes, which exceeds the specified depths with 2,500 psi concrete, crushed stone, washed shell, or other material as directed. Include refilling of over-excavated space in rock as part of the rock excavation.

- G. Other Requirements: Follow, where applicable, the requirements of the subsections on "Trench Excavation" and "Structure Excavation".
- H. Payment: No additional payment will be made for rock excavation.

3.6 FINISHED EXCAVATION

- A. Finish: Provide a reasonably smooth finished surface for all excavations, which is uniformly compacted and free from irregular surface changes.
- B. Finish Methods: Provide a degree of finish that is ordinarily obtainable from blade-grade operations and in accordance with Section 312323.

3.7 PROTECTION

- A. Traffic and Erosion: Protect newly graded areas from traffic and from erosion.
- B. Repair: Repair any settlement or washing away that may occur from any cause, prior to acceptance. Re-establish grades to the required elevations and slopes.
- C. It shall be the CONTRACTOR's responsibility to acquaint himself with all existing conditions and to locate all structures and utilities along the proposed utility alignment in order to avoid conflicts. Where actual conflicts are unavoidable, coordinate work with the facility owner and perform work so as to cause as little interference as possible with the service rendered by the facility disturbed in accordance with Section 020500. Repair and/or replace facilities or structures damaged in the prosecution of the work immediately, in conformance with current standard practices of the industry, or according to the direction of the owner of such facility, at the CONTRACTOR's expense.
- D. Other Requirements: Conduct all Work in accordance with the environmental protection requirements specified in Division 1.

3.8 AUTHORIZED ADDITIONAL EXCAVATION

- A. Additional Excavation: Carry the excavation to such additional depth and width as authorized in writing, for the following reasons:
 - 1. In case the materials encountered at the elevations shown are not suitable.
 - 2. In case it is found desirable or necessary to go to an additional depth, or to an additional depth and width.
- B. Refill Materials: Refill such excavated space with either authorized 2500 psi concrete or compacted select fill material, in compliance with the applicable provisions of Section 312323.

- C. Compaction: Compact fill materials to avoid future settlement. As a minimum, backfill layers shall not exceed 6-inches in thickness for the full trench width and compaction shall equal 95% of maximum density, or 98% if under paved area of roadway, as determined by using ASTM D 1557. Perform compaction density tests at all such backfill areas with spacing not to exceed 100 feet apart and on each 6-inch compacted layer.
- D. Payment: Additional earth excavations so authorized and concrete or select fill materials authorized for filling such additional excavation and compaction of select fill materials will be paid for under the appropriate Contract Items or where no such items exist, as a change in the Work.

3.9 UNAUTHORIZED EXCAVATION

- A. Stability: Refill any excavation carried beyond or below the lines and grades shown, except as specified in the subsection headed "Authorized Additional Excavation", with such material and in such manner as may be approved in order to provide for the stability of the various structures.
- B. Refill Materials: Refill spaces beneath all manholes, structures, pipelines, or conduits excavated without authority with 2500 psi concrete or compacted select fill material, as approved.
- C. Payment: Refill for unauthorized excavation will not be measured and no payment will be made therefor.

3.10 SEGREGATION STORAGE AND DISPOSAL OF MATERIAL

- A. Stockpiling Suitable Materials: Stockpile topsoil suitable for final grading and landscaping and excavated material suitable for backfilling or embankments separately on the site in approved locations.
- B. Stockpile Locations: Store excavated and other material a sufficient distance away from the edge of any excavation to prevent its falling or sliding back into the excavation and to prevent collapse of the wall of the excavation. Provide not less than 2 feet clear space between the top of any stockpile and other material and the edge of any excavation.
- C. Excess Materials: Be responsible for transport and disposal of surplus excavated material and excavated material unsuitable for backfilling or embankments at an off site disposal location secured by the CONTRACTOR.

3.11 REMOVAL OF WATER

- A. Water Removal: At all times during the excavation period and until completion and acceptance of the WORK at final inspection, provide ample means and equipment with which to remove promptly and dispose of properly all water entering any excavation or other parts of the WORK.

- B. Dry Excavations: Keep the excavation dry, in accordance with Section 312319.
- C. Water Contact: Allow no water to rise over or come in contact with masonry and concrete until the concrete and mortar have attained a set and, in any event, not sooner than 12 hours after placing the masonry or concrete.
- D. Discharge of Water: Dispose of water pumped or drained from the Work in a safe and suitable manner without damage to adjacent property or streets or to other work under construction.
- E. Protection: Provide adequate protection for water discharged onto streets. Protect the street surface at the point of discharge.
- F. Sanitary Sewers: Discharge no water into sanitary sewers.
- G. Storm Sewers: Discharge no water containing settleable solids into storm sewers.
- H. Repair: Promptly repair any and all damage caused by dewatering the Work.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 312319

GROUNDWATER CONTROL FOR OPEN CUT EXCAVATION

PART 1 GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

- A. This section provides for furnishing all permits, labor, materials, equipment, power and incidentals for performing all operations necessary to dewater, depressurize, drain and maintain excavations as described herein and as necessary for installation of pipeline and appurtenances. Included are installing, maintaining, operating and removing dewatering systems and other approved devices for the control of surface and groundwater during the construction of pipelines and appurtenances, open cut excavations, directional drilling. Included also are protecting work against rising waters and repair of any resulting damage.

1.2 CONTRACTOR'S RESPONSIBILITY

- A. It is the sole responsibility of the CONTRACTOR to identify groundwater conditions and to provide any and all labor, material, equipment, techniques and methods to lower, control and handle the groundwater as necessary for his construction methods and to monitor the effectiveness of this installed system and its effect on adjacent facilities.
- B. Operate, maintain and modify the system(s) as required to conform to these Specifications. Upon completion of the Construction, remove the system(s). The development, drilling and abandonment of all wells used in the dewatering system shall comply with regulations of the Florida Department of Environmental Protection and the governing Water Management District.
- C. Assume sole responsibility for dewatering systems and for all loss or damage resulting from partial or complete failure of protective measures and any settlement or resultant damage caused by the dewatering operation.

1.3 PLANS AND OTHER DATA TO BE SUBMITTED

- A. Prior to commencement of work, submit complete drawings, details and layouts showing the proposed dewatering plans in sufficient detail (i.e., general arrangements, procedures to be used, etc.) so as to allow the ENGINEER to evaluate the proposed dewatering systems. Include the following, as required by the CONTRACTOR's proposed operation:
 - 1. Names of equipment suppliers.
 - 2. Names of installation subcontractors.

3. Plan for dewatering at access shafts and control of surface drainage.
4. Plan for dewatering for cut-and-cover excavations, or otherwise controlling groundwater.
5. Eductor system layout and details.
6. Deep well locations and details.
7. Well point system layout and details.
8. Installation reports for eductors, deep wells and well points.
9. Water level readings from piezometers or observation wells, and method of maintenance.
10. As part of his request for approval of a dewatering system, demonstrate the adequacy of the proposed system and well point filler sand by means of a test installation.

PART 2 PRODUCTS

- A. Select equipment including but not limited to pumps, eductors, well points and piping and other material desired.

PART 3 EXECUTION

3.1 DEWATERING EXCAVATIONS

- A. Obtain all permits necessary for dewatering operations and file a copy of all such permits with the County Manager or designee and ENGINEER.
- B. Furnish, install, operate and maintain all necessary equipment for dewatering the various parts of the Work and for maintaining free of water the excavations and such other parts of the Work as required for Construction operations. Dewatering system should provide for continuous operation including nights, weekends, holidays, etc. Provide appropriate backup if electrical power is primary energy source for dewatering system.
- C. Continue dewatering in all required areas, until the involved work is completed, including the placing and compaction of backfill materials.
- D. Provide a uniform diameter for each pipe drain run constructed for dewatering. Remove the pipe drain when it has served its purpose. If removal of the pipe is impractical, provide grout connections at 50-foot intervals, and fill the pipe with clay grout or cement and sand grout when the pipe has served its purpose.

3.2 DEWATERING TRENCH

- A. Dewatering Excavation Plan: Develop an excavation dewatering plan that considers site ground and groundwater conditions, the type and arrangement of the equipment to be used and the proper method of groundwater disposal. Prepare the dewatering plan before beginning excavations below groundwater. Maintain one copy of the dewatering plan at the project site to be available for inspection while all dewatering operations are underway.
- B. Do not lay any pipeline in a trench in the presence of water. Remove all water from the trench sufficiently ahead of the pipeline placing operation. The ENGINEER shall have full and final authority to require dewatering of the trench to ensure a dry, firm bed on which to place the pipeline. As a minimum, maintain water levels at least 6 inches below the bottom of the trench. Continue to dewater trench until trench backfilling operations have been completed.
 - 1. If a dry trench bottom has not been obtained with usual methods of trench dewatering, then the order to excavate below grade and place sufficient select fill material, crushed stone, or 2500 psi concrete over the trench bottom may be given.
 - 2. If all efforts fail to obtain a stable dry trench bottom, and it is determined that the trench bottom is unsuitable for pipe foundation, present an alternate system for stabilization to the Engineer of Record for approval by the County Manager or designee on a case-by-case basis.
- C. Removal of water may be accomplished by pumping in connection with well point installation as the particular situation may warrant.
- D. If the soils encountered at the trench grade are suitable for the passage of water, without destroying the sides or utility foundation of the trench, sumps may be provided at intervals at the side of the main trench excavation. Use pumps to lower the water level by taking their suction from said sumps.

3.3 REQUIREMENTS FOR EDUCTOR, WELL POINTS OR DEEP WELLS

- A. Eductor, well points or deep wells, where used, must be furnished, installed and operated by a reputable CONTRACTOR regularly engaged in this business, and approved.

3.4 DURATION OF DRAINAGE

- A. In areas where concrete is to be placed, carry out the foundation drainage so that the required lowering of the water table will be effected prior to placing reinforcing steel. Keep foundation beds free from water to the same levels for 3 days after placing concrete.

3.5 PROTECTION OF STRUCTURES

- A. Provide adequate protection for all structures to avoid damage to concrete.
- B. Operate construction equipment over completed concrete slabs or structures only with approval. Rubber tire equipment heavier than 5 tons and crawlers heavier than 7 tons will require adequate load spreading by sand fill or other means.

3.6 DISCHARGE OF WATER

- A. Do not discharge pumped drainage water into the sanitary sewer system or inhibit pedestrian or vehicular traffic with the groundwater control system.
- B. Discharge pumped drainage water into the storm sewer system or drainage ditch by direct means (i.e., discharge hose to inlet, burying header, etc.). Monitor the discharged water to determine that soil particles are not being removed.
- C. Conform all discharge to current South Florida Water Management District and Collier County Department of Stormwater Management rules, regulations, procedures and regulatory permits and if discharged into receiving waters, shall not exceed 29 N.T.U.'s above background.

3.7 REPAIR OF DAMAGE

- A. Assume full responsibility for all loss and damage due to flooding, rising water or seepage resulting from dewatering operations in any part of the work. Repair any damage to partially completed work from these or other causes, including the removal of slides, repair of foundation beds and performance of any other work necessitated by lack of adequate dewatering or drainage facilities.

END OF SECTION

SECTION 312323

BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

- A. General Requirements: Backfill all excavation to the original surface of the ground or to such other grades as may be shown or required. For areas to be covered by topsoil, leave or stop backfill (12) inches below the finished grade. Obtain approval for the time elapsing before backfilling against masonry structures. Remove from all backfill, any compressible, putrescible, or destructible rubbish and refuse and all lumber and braces from the excavated space before backfilling is started. Leave sheeting and bracing in place or remove as the work progresses.
- B. Equipment Limitations: Do not permit construction equipment used to backfill to travel against and over cast-in-place concrete structures until the specified concrete strength has been obtained, as verified by concrete test cylinders. In special cases where conditions warrant, the above restriction may be modified providing the concrete has gained sufficient strength, as determined from test cylinders, to satisfy design requirements for the removal of forms and the application of load.
- C. Related Work Specified In Other Sections Includes:
 - 1. Section 017416 – Site Clearing
 - 2. Section 312316 – Excavation – Earth and Rock

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. ASTM D 1557 - Standard Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures Using 10 lb Rammer and 18 in Drop

PART 2 PRODUCTS

2.1 BACKFILL MATERIAL - GENERAL

- A. General: Refer to Utilities Standards and Procedures Ordinance Section 9.1.2 for laying and backfilling requirements. Backfill with sound materials, free from waste, organic matter, rubbish, boggy or other unsuitable materials. Acceptable backfill shall not contain rocks or stones larger than 2 inches in size.

- B. General Materials Requirements: Conform materials used for backfilling to the requirements specified. Follow common fill requirements whenever drainage or select fill is not specified. Determine and obtain the approval of the appropriate test method where more than one compaction test method is specified.
- C. Classification of Approved Embedment Materials: Embedment materials listed here include a number of processed materials plus the soil types defined according to the Unified Soil Classification System (USCS) in ASTM D2487. These materials are grouped into 5 broad categories according to their suitability for this application.
1. Class I: Angular, 0.25 inch to 1.5 inch (6 to 40 mm) graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed shells and crushed stone. (Note: The size range and resulting high void ratio of Class I material makes it suitable for use to dewater trenches during pipe installation. This permeable characteristic dictates that its use be limited to locations where pipe support will not be lost by migration of fine grained natural material from the trench walls and bottom or migration of other embedment materials into the Class I material. When such migration is possible, the material's minimum size range should be reduced to finer than 0.25 inch (6 mm) and the gradation properly designed to limit the size of the voids. An alternative to modifying the gradation is to use a geotextile fabric as a barrier to migration to fines.)
 2. Class II: Coarse sands and gravels with maximum particle size of 1.5 inches (40 mm), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW and SP are included in this class. (Note: Sands and gravels, which are clean or borderline between clean and with fines, should be included. Coarse-grained soils with less than 12 percent, but more than 5 percent fines are neglected in ASTM D2487 and the USCS, but should be included. The gradation of Class II material influences its density and pipe support strength when loosely placed. The gradation of Class II material may be critical to the pipe support and stability of the foundation and embedment, if the material is imported and is not native to the trench excavation. A gradation other than well graded, such as uniformly graded or gap graded, may permit loss of support by migration into void spaces of a finer grained natural material from the trench wall and bottom. An alternative to modifying the gradation is to use a geotextile fabric as a barrier to migration of fines.)
 3. Class III: Fine sand and clayey (clay filled) gravels, including fine sands, sand-clay mixtures and gravel-clay mixtures. Soil Types GM, GC, SM and SC are included in this class.

4. Class IV: Silt, silty clays and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class. (Note: Use caution in the design and selection of the degree and method of compaction for Class IV soils because of the difficulty in properly controlling the moisture content under field conditions. Some Class IV soils with medium to high plasticity and with liquid limits greater than 50 percent (CH, MH, CH-MH) exhibit reduced strength when wet and should only be used for bedding, haunching and initial backfill in arid locations where the pipe embedment will not be saturated by groundwater, rainfall or exfiltration from the pipe. Class IV soils with low to medium plasticity and with liquid limits lower than 50 percent (CL, ML, CL-ML) also require careful consideration in design and installation to control moisture content, but need not be restricted in use to arid locations.)
5. Class V: This class includes the organic soils OL, OH and PT as well as soils containing frozen earth, debris, rocks larger than 1.5 inches (40 mm) in diameter and other foreign materials. Do not use these materials for bedding, haunching or backfill.

2.2 SELECT FILL

- A. Materials for Select Fill: Use clean gravel, crushed stone, washed shell, or other granular or similar material as approved which can be readily and thoroughly compacted to 95 percent of the maximum dry density obtainable by ASTM D 1557.

1. Allowed Materials: Grade select fill between the following limits:

U.S. Standard Sieve	Percent Passing By Weight
2 inch	100
1-1/2 inch	90-100
1 inch	75-95
1/2 inch	45-70
#4	25-50
#10	15-40
#200	5-15

2. Unallowed Materials: Very fine sand, uniformly graded sands and gravels, sand and silt, soft earth, or other materials that have a tendency to flow under pressure when wet are unacceptable as select fill.

2.3 COMMON FILL

- A. Materials for Common Fill: Material from on-site excavation may be used as common fill provided that it can be readily compacted to 90 percent of the maximum dry density obtainable by ASTM D 1557, and does not contain unsuitable material. Select fill may be used as common fill at no change in the Contract Price.
- B. Granular Materials On-Site: Granular on-site material, which is fairly well graded between the following limits may be used as granular common fill:

U.S. Standard Sieve	Percent Passing by Weight
2 inch	100
#10	50-100
#60	20-90
#200	0-20

- C. Cohesive Materials On-Site: Cohesive site material may be used as common fill.
 - 1. The gradation requirements do not apply to cohesive common fill.
 - 2. Use material having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20.
- D. Material Approval: All material used as common fill is subject to approval. If there is insufficient on-site material, import whatever additional off-site material is required which conforms to the specifications and at no additional cost.

2.4 UTILITY PIPE BEDDING

- A. Gradation for Small Piping: For pipe 18 inches or less in diameter, use pipe bedding of material 90 percent of which will be retained on a No. 8 sieve and 100 percent of which will pass a 1/2-inch sieve and be well graded between those limits.
- B. Gradation for Large Piping: For pipe larger than 18 inches in diameter, use the same pipe bedding material as specified for smaller pipe or use a similar well graded material 90 percent of which will be retained on a No. 8 sieve and 100 percent of which will pass a 1-inch sieve.
- C. Provide a minimum of six (6) inches bedding material under all gravity sewer piping. In areas where poor soil conditions or rock exist, provide a minimum of six (6) inches of pipe bedding material under water or force main pressure pipe.

PART 3 EXECUTION

3.1 PRECAST MANHOLE BEDDING

- A. Bedding Compaction: Bed all precast manholes in well graded, compacted 12-inch layer of crushed stone. Compact bedding thickness no less than 6 inches for precast concrete manhole bases.
- B. Concrete Work Mats: Cast cast-in-place manhole bases and other foundations for structures against a 2500 psi concrete work mat in clean and dry excavations.
- C. Bedding Placement: Place select fill used for bedding beneath precast manhole bases, in uniform layers not greater than 9 inches in loose thickness. Thoroughly compact in place with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.
- D. Use of Select Fill: Bed existing underground structures, tunnels, conduits and pipes crossing the excavation with compacted select fill material. Place bedding material under and around each existing underground structure, tunnel, conduit or pipe and extend underneath and on each side to a distance equal to the depth of the trench below the structure, tunnel, conduit or pipe.

3.2 PIPE BEDDING AND INITIAL BACKFILL

- A. Placement: Place backfill for initial pipe backfill from top of bedding to 1 foot over top of pipes in uniform layers not greater than 8 inches in loose thickness. Tamp under pipe haunches and thoroughly compact in place the backfill with suitable mechanical or pneumatic tools to not less than 98 percent of the maximum dry density as determined by ASTM D 1557.
- B. Foundation Bedding: Place bedding, to a depth specified by the County Manager or designee, as a foundation in wet, yielding or mucky locations. Construct foundation bedding by removal of the wet, yielding or mucky material and replacement with sufficient Class I material to correct soil instability.
- C. Stone Placement: Do not place large stone fragments in the pipe bedding or backfill within 2 feet over or around pipelines, or nearer than 2 feet at any point from any casing pipe, conduit or concrete wall.
- D. Machine Compaction: Machine Compaction of initial backfill is prohibited unless adequate cover as deemed by the County Manager or designee is provided. In no case shall adequate cover be less than 12 inches.
- E. Unallowed Materials: Pipe bedding containing very fine sand, uniformly graded sands and gravels, sand and silt, soft earth, or other materials that have a tendency to flow under pressure when wet is unacceptable.

3.3 TRENCH BACKFILL

- A. General: Backfill trenches from 1 foot over the top of the pipe, from the top of electrical duct bedding or as shown to the bottom of pavement base course, subgrade for lawns or lawn replacement, to the top of the existing ground surface or to such other grades as may be shown or required.
- B. Materials: All backfill material shall be acceptable dry materials, and shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks, or stones, or other deleterious material which in the opinion of the County Manager or designee is unsuitable.
- C. Depth of Placement - Place trench backfill in uniform layers not greater than 12 inches in loose thickness and that can be thoroughly compacted in place using suitable mechanical or pneumatic equipment to not less than 98 percent of the maximum dry density as determined by ASTM D 1557.
- D. Depth of Placement - Undeveloped Areas: In nondeveloped areas and where select fill material or hand-placed backfill are not specified or required, place suitable job-excavated material or other approved backfill in lifts not exceeding 12 inches in loose thickness. Lifts of greater thickness may be permitted by the County Manager or designee if the CONTRACTOR demonstrates compliance with required densities. When the trench is full, consolidate the backfill by jetting, spading, or tamping to ensure complete filling of the excavation. Mound the top of the trench approximately 12 inches to allow for consolidation of backfill.
- E. Compaction: Compact backfill as a percentage of the maximum density at optimum moisture content as determined by the standard proctor test, ASTM D698 as demonstrated in the following table:

Area	(Mod.) ASTM D1557
Around and 1' (Min) above top of pipe	98
Remaining Trench	98
Pavement Sub-Grade and Shoulders (Last 3' of Fill)	98
Base Material and Pavement	98
Adjacent to Structures (Areas not Paved)	98
Under Structures	98
Sub-Base	98

- F. Density Tests: Density tests will be made at the request of the County Manager or designee. Deficiencies will be corrected at the expense of the CONTRACTOR.
- G. Dropping of Material on Work: Do trench backfilling work in such a way as to prevent dropping material directly on top of any conduit or pipe through any great vertical distance.

- H. Distribution of Large Materials: Break lumps up and distribute any stones, pieces of crushed rock or lumps which cannot be readily broken up, throughout the mass so that all interstices are solidly filled with fine material.

3.4 STRUCTURE BACKFILL

- A. Use crushed stone underneath all structures, and adjacent to structures where pipes, connections and structural foundations are to be located within this fill. Use crushed stone beneath all pavements, walkways, and railroad tracks, and extend to the bottom of pavement base course or ballast.
 - 1. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable approved mechanical or pneumatic equipment.
 - 2. Compact backfill to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.
- B. Use of Common Fill: Use common granular fill adjacent to structures in all areas not specified above. Select fill may be used in place of common granular fill at no additional cost.
 - 1. Extend such backfill from the bottom of the excavation or top of bedding to the bottom of subgrade for lawns or lawn replacement, the top of previously existing ground surface or to such other grades as may be shown or required.
 - 2. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable equipment, as specified above.
 - 3. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

3.5 COMPACTION EQUIPMENT

- A. Equipment and Methods: Carry out all compaction with suitable approved equipment and methods.
 - 1. Compact clay and other cohesive material with sheep's-foot rollers or similar equipment where practicable. Use hand held pneumatic tampers elsewhere for compaction of cohesive fill material.
 - 2. Compact low cohesive soils with pneumatic-tire rollers or large vibratory equipment where practicable. Use small vibratory equipment elsewhere for compaction of cohesionless fill material.

3. Do not use heavy compaction equipment over pipelines or other structures, unless the depth of fill is sufficient to adequately distribute the load.

3.6 FINISH GRADING

- A. Final Contours: Perform finish grading in accordance with the completed contour elevations and grades shown and blend into conformation with remaining natural ground surfaces.
 1. Leave all finished grading surfaces smooth and firm to drain.
 2. Bring finish grades to elevations within plus or minus 0.10 foot of elevations or contours shown.
- B. Surface Drainage: Perform grading outside of building or structure lines in a manner to prevent accumulation of water within the area. Where necessary or where shown, extend finish grading to ensure that water will be carried to drainage ditches, and the site area left smooth and free from depressions holding water.

3.7 RESPONSIBILITY FOR AFTERSETTLEMENT

- A. Aftersettlement Responsibility: Take responsibility for correcting any depression which may develop in backfilled areas from settlement within one year after the work is fully completed. Provide, as needed, backfill material, pavement base replacement, permanent pavement, sidewalk, curb and driveway repair or replacement, and lawn replacement, and perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as approved.

3.8 INSPECTION AND TESTING OF BACKFILLING

- A. Sampling and Testing: Provide sampling, testing, and laboratory methods in accordance with the appropriate ASTM Standard Specification. Subject all backfill to these tests.
- B. Correction of Work: Correct any areas of unsatisfactory compaction by removal and replacement, or by scarifying, aerating or sprinkling as needed and recompaction in place prior to placement of a new lift.
- C. Testing Schedule:
 1. Compaction Schedule
 2. Optimum Moisture Content (Proctor Test)

END OF SECTION

SECTION 314000

SHORING, SHEETING AND BRACING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Work required for protection of an excavation or structure through shoring, sheeting, and bracing.
- B. Related Work Specified In Other Sections Includes:
 - 1. Section 312316 – Excavation – Earth and Rock
 - 2. Section 312323 – Backfilling

1.2 SUBMITTALS

- A. General: Provide all submittals, including the following, as specified in Division 1.
- B. CONTRACTOR's Submittals: All sheeting and bracing shall be the responsibility of the CONTRACTOR to retain qualified design services for these systems, and to be completed with strict adherence to OSHA Regulations. Submit complete design calculations and working drawings of proposed shoring, sheeting and bracing which have been prepared, signed and sealed by a Licensed Professional Engineer experienced in Structural Engineering and registered in the State of Florida, before starting excavation for jacking pits and structures. Use the soil pressure diagram shown for shoring, sheeting and bracing design. ENGINEER's review of calculations and working drawings will be limited to confirming that the design was prepared by a licensed professional engineer and that the soil pressure diagram shown was used.

1.3 REFERENCES

- A. Design: Comply with all Federal and State laws and regulations applying to the design and construction of shoring, sheeting and bracing.
- B. N.B.S. Building Science Series 127 "Recommended Technical Provisions for Construction Practice in Shoring and Sloping Trenches and Excavations."

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Do work in accordance with the U.S. Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54), and the Florida

Trench Safety Act. Observe 29 CFR 1910.46 OSHA regulations for Confined Space Entry.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND MATERIALS

- A. Material Recommendations: Use manufacturers and materials for shoring, sheeting and bracing as recommended by the Licensed Professional Engineer who designed the shoring, sheeting, and bracing.

- 1. Wood Materials: Oak, or treated fir or pine for wood lagging.

PART 3 EXECUTION

3.1 SHORING, SHEETING AND BRACING INSTALLATION

- A. General: Provide safe working conditions, to prevent shifting of material, to prevent damage to structures or other work, to avoid delay to the work, all in accordance with applicable safety and health regulations. Properly shore, sheet, and brace all excavations which are not cut back to the proper slope and where shown. Meet the general trenching requirements of the applicable safety and health regulations for the minimum shoring, sheeting and bracing for trench excavations.
 - 1. CONTRACTOR's Responsibility: Sole responsibility for the design, methods of installation, and adequacy of the shoring, sheeting and bracing.
- B. Arrange shoring, sheeting and bracing so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength.
- C. If ENGINEER is of the opinion that at any point the shoring, sheeting or bracing are inadequate or unsuited for the purpose, resubmission of design calculations and working drawings for that point may be ordered, taking into consideration the observed field conditions. If the new calculations show the need for additional shoring, sheeting and bracing, it should be installed immediately.
- D. Monitoring: Periodically monitor horizontal and vertical deflections of sheeting. Submit these measurements for review.
- E. Accurately locate all underground utilities and take the required measures necessary to protect them from damage. Keep all underground utilities in service at all times as specified in Division 1.

- F. Driven Sheet piling: Drive tight sheet piling in that portion of any excavation in paved or surface streets City collector and arterial streets and in State and County highways below the intersection of a one-on-one slope line from the nearest face of the excavation to the edge of the existing pavement or surface.
- G. Sheet piling Depth: In general drive or place sheet piling for pipelines to a depth at elevation equal to the top of the pipe as approved.
1. If it is necessary to drive sheet piling below that elevation in order to obtain a dry trench or satisfactory working conditions, cut the sheet piling off at the top of the pipe and leave in place sheet piling below the top of the pipe.
 2. Do not cut the sheet piling until backfill has been placed and compacted to the top of the pipe.
- H. Sheet piling Removal: In general, remove sheet piling and bracing above the top of the pipe as the excavation is refilled in a manner to avoid the caving in of the bank or disturbance to adjacent areas or structures. Remove sheet piling as backfilling progresses so that the sides are always supported or when removal would not endanger the construction of adjacent structures. When required to eliminate excessive trench width or other damages, shoring or bracing shall be left in place and the top cut off at an elevation 2.5 feet below finished grade, unless otherwise directed.
1. Carefully fill voids left by the withdrawal of the sheet piling by jetting, ramming or otherwise.
 2. No separate payment will be made for filling of such voids.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 320117

PAVEMENT REPAIR AND RESTORATION

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and remove and replace pavements over trenches excavated for installation of pipelines as shown on the drawings and/or specified herein.

1.2 GENERAL

- A. Repair all damage, as a result of work under this project, done to existing pavement, driveways, paved areas, curbs and gutters, sidewalks, shrubbery, grass, trees, utility poles, utility pipe lines, conduits, drains, catch basins, or stabilized areas or driveways and including all obstructions not specifically named herein, in a manner satisfactory to the ENGINEER. Include in the bid price, the furnishing of all labor, materials, equipment, and incidentals necessary for the cutting, repair, and restoration of the damaged areas unless pay items for specific types of repair are included in the Bid Form.
- B. Keep the surface of the backfilled area of excavation in a safe condition and level with the remaining pavement until the pavement is restored in the manner specified herein. All surface irregularities that are dangerous or obstructive to traffic are to be removed. Conform the repair to applicable COUNTY or State requirements for pavement repair and as described herein.
- C. The COUNTY reserves the right to require soil bearing or loading tests or materials tests, should the adequacy of the foundation or the quality of materials used be questionable. Costs of these tests shall be the responsibility of the COUNTY, if found acceptable; the costs of all failed tests shall be the responsibility of the CONTRACTOR.
- D. Make all street and road repair in accordance with the details indicated on the drawings and in accordance with the applicable requirements of these Specifications and meeting the permit requirements and approval of the governing Department of Transportation agencies.
- E. Replace pavement or roadway surfaces cut or damaged in equal or better condition than the original, including stabilization, base course, surface course, curb and gutter or other appurtenances. Obtain the necessary permits prior to any roadway work. Provide advance notice to the appropriate authority, as required, prior to construction operations.

1. Roadway Restoration (within Collier County Department of Transportation & Engineering jurisdiction): Perform restoration in accordance with the requirements set forth in the "Right-of-Way Utility Construction Activities Policy" and these Standards. Obtain prior approval from Collier County DOT for the materials of construction and method of installation, along with the proposed restoration design for items not referred or specified herein.
 - a. Where existing pavement is to be removed, mechanical saw cut the surface prior to trench excavation, leaving a uniform and straight edge parallel or perpendicular to the roadway centerline with minimum disturbance to the remaining adjacent surfacing. Provide minimal width of cut for this phase of existing pavement removal.
 - b. Immediately following the specified backfilling and compaction, apply a temporary sand seal coat surface to the cut areas. For this temporary surfacing, provide a smooth traffic surface with the existing roadway and maintain until final restoration. Ensure that surfacing remains for a minimum of ten (10) days in order to assure the stability of the backfill under normal traffic conditions. Thirty (30) days following this period and prior to sixty (60) days after application: remove the temporary surfacing and perform final roadway surface restoration.
 - c. In advance of final restoration, remove the temporary surfacing and mechanically saw the existing pavement straight and clean to the stipulated dimensions, if needed. Following the above operation, proceed immediately with final pavement restoration in accordance with the requirements set forth by Collier County Department of Transportation.
 - d. No layer shall be greater than two inches (2") when compacted. Where a surface course is constructed to a thickness greater than two inches (2"), construct it in approximately equal layers, each not exceeding two inches (2").
 - e. Where necessitated by traffic conditions, lay mixture in strips in such manner as to provide for the passage of traffic. Where the road is closed to traffic, mixture may be laid to the full width, by machines traveling in parallel.
2. Roadway Restoration (outside Collier County Department of Transportation jurisdiction) – Conform work within the rights-of-way of public thoroughfares which are not under jurisdiction of Collier County to the requirements of the Governmental agency having jurisdiction or the Florida Department of Transportation, if no governmental agencies have jurisdiction. Work within State Highway right-of-way shall be in full compliance with all requirements of the permit drawings, and to the satisfaction of the Florida Department of Transportation.

1.3 QUALITY ASSURANCE

- A. Applicable provisions of the latest version of the Florida Department of Transportation "Standard Specifications for Road and Bridge Construction", and Supplemental Specifications hereunder govern the work under this Section. The Florida Department of Transportation will hereafter be referred to as FDOT.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Use materials for flexible base pavement and base course as specified in the latest version of the Florida Department of Transportation "Standard Specifications for Road and Bridge Construction".

PART 3 EXECUTION

3.1 CUTTING PAVEMENT

- A. Cut and remove pavement to straight edges, 6 inches outside each edge of proposed trench to avoid pavement damage during installation of the new pipelines and appurtenances and for making connections to existing pipelines.
- B. Before removing pavement, mark the pavement for cuts nearly paralleling pipelines and existing street lines. Cut asphalt pavement along the markings with a jackhammer, rotary saw, or other suitable tool.
- C. No pavement shall be machine pulled until completely broken and separated along the marked cuts.
- D. The pavement adjacent to pipeline trenches shall neither be disturbed nor damaged. If the adjacent pavement is disturbed or damaged, irrespective of cause, remove the damaged pavement replace it at CONTRACTOR's expense.

3.2 GENERAL RESTORATION

- A. Restore, replace or rebuild existing street paving, driveways, etc., using the same type of construction as was in the original. Be responsible for restoring all such work, including sub-grade and base courses where present. Obtain and pay for such local or other governmental permits as may be necessary for the opening of streets. Meet any requirements other than those herein set forth which may affect the type, quality and manner of carrying on the restoration of surfaces by reason of jurisdiction of such governmental bodies.
- B. In all cases, maintain, without additional compensation, all permanent replacement of street paving, done by him under this Contract until accepted by the County Manager or designee, including the removal and replacement of such

work wherever surface depressions or underlying cavities result from settlement of trench backfill.

- C. Complete all the final resurfacing or re-paving of streets or roads, over the excavations and relay paving surfaces of roadbed that have failed or been damaged prior to acceptance by the County Manager or designee. Conform backfilling of trenches and the preparation of sub-grades to the requirements of Section 312323.
- D. Do all re-paving or resurfacing in accordance with Florida Department of Transportation Specifications, to which the following requirement of trench backfill will be added: Where pipeline construction crosses paved areas such as streets, backfill the top 24 inches of trench below the road bases or concrete slabs with compacted A-4 or better material that will provide a bearing value of not less than 75 when tested by the Florida Department of Transportation Soil Bearing Test Methods.

3.3 PRIME AND TACK COATS

- A. Apply bituminous prime and tack coats on the previously prepared base course in accordance with Section 300 of the FDOT Specifications.

3.4 WEARING COURSE

- A. Use plant-mixed hot bituminous pavement to the thickness indicated in the drawings conforming to Type III asphaltic concrete in accordance with Section 333 of the FDOT Specifications. The requirements for plant and equipment are specified in Section 320 and the general construction requirements for asphaltic concrete pavement are contained in Section 330 of the FDOT specifications.

3.5 TESTING

- A. Perform all field-testing at an independent laboratory employed by the COUNTY. Test and certify all materials by the producer. Repeat tests of sub-grade or base not meeting specified compaction at the CONTRACTOR's expense.

3.6 MISCELLANEOUS RESTORATION

- A. Restore sidewalks, cut or damaged by construction, in full sections or blocks to a minimum thickness of four inches. Restore concrete curb or curb gutter to the existing height and cross section in full sections or lengths between joints. Concrete shall be as specified on the drawings. Restore grassed yards, shoulders and parkways to match the existing sections with grass seed or sod of a type matching the existing grass.

3.7 CLEANUP

- A. After all repair and restoration or paving has been completed, remove all excess asphalt, dirt, and other debris from the roadways. Check and clean all existing storm sewers and inlets of any construction debris.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 321300
SIDEWALKS, DRIVEWAYS AND CURBS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Sidewalks, sidewalk ramps, driveways, curbs and drive approaches complete with concrete materials, concrete curing compounds, joint materials, field quality control and appurtenances.

1.2 REFERENCES

- A. Reference Standards: Conform the work for this Section to the applicable portions of the following standard Specifications.
 - 1. ASTM - American Society of Testing and Materials
 - 2. AASHTO - American Association of State Highway and Transportation Officials
 - 3. FDOT - Florida Department of Transportation - Standard Specifications for Road and Bridge Construction.
 - 4. FAC - Florida Accessibility Code.
 - 5. ADAAG - American with Disabilities Act Accessibility Guidelines
 - 6. UFAS - Uniform Federal Accessibility Standards

1.3 SUBMITTALS

- A. Reports: Written permission for the use of all local disposal sites Furnish copies to the ENGINEER.
- B. Test Reports:
 - 1. Thickness and Compressive Strength: Provide the ENGINEER with two (2) certified copies of the test results. Perform the tests by a laboratory approved by the ENGINEER.

1.4 JOB CONDITIONS

- A. Environmental Requirements:

1. Temperature: Comply with the requirements for concrete installation due to outside ambient air temperatures as specified under Article 3.3.I of this Section.
- B. Protection:
1. Protection Against Rain: Comply with the requirements for protecting new work against damage from Rain, as specified under Article 3.3.I of this Section.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete: Use 2,500-psi concrete except as modified herein.
- B. Ready-Mixed Concrete: Use ready-mixed concrete that conforms to ASTM C94, Alternate 2.
- C. Water: Use water for mixing and curing concrete reasonably clean and free from oil, salt, acid, alkali, chlorides, sugar, vegetable, or other substances injurious to the finished product. Waters from sources approved by the local Health Department as potable may be used without test. Test water requiring testing in accordance with the current Method of Test for Quality of Water to be Used in Concrete, AASHTO T-26.
- D. Concrete Curing Compounds: Use white membrane curing compound for curing concrete that conforms to AASHTO M148, Type 1 clear, or Type 2 while per FDOT Section 925.
- E. Premolded Joint Filler: Use fiber joint filler that conforms to ASTM D1751. Use filler of the thickness, as specified herein, or as directed by the ENGINEER.
- F. Steel Hook Bolts: Use hook bolts that conform to ASTM A706, or for Grade 60 of ASTM A615, A616, or A617. Use 5/8-inch diameter hook bolts self-tapping.
- G. Joint Sealant: Use hot-poured type joint sealant that conforms to ASTM D1190.

PART 3 EXECUTION

3.1 CONTRACTOR'S VERIFICATION

- A. Excavation and Forming: Prior to the installation of any concrete, examine the excavation and forms for the proper grades, lines, and levels required to receive the new work. Ascertain that all excavation and compacted subgrades are adequate to receive the concrete to be installed.

1. Correct all defects and deficiencies before proceeding with the work.
- B. Existing Improvements: Investigate and verify location of existing improvements to which the new work is to be connected.
1. Making necessary adjustment in line and grade to align the new work with the existing improvements must be approved by the ENGINEER prior to any change.

3.2 PREPARATION

- A. Forms: Use wood or metal forms, straight and free from warp, clean, and sufficient strength to resist springing during the process of depositing concrete against them.
1. Use full depth of the concrete forms.

3.3 INSTALLATION

- A. Sidewalks, Sidewalk Ramps, Driveways and Driveway Approaches: Construct all sidewalks and sidewalk ramps four (4) inches thick except at driveways and alleys. Construct thickness of the sidewalks six (6) inches at driveways and alleys. Construct sidewalks five (5) feet wide unless otherwise noted on the Plans, and slope 1/4-inch per foot towards the center of the road. Normally, sidewalks will be located within the right-of-way, parallel the property lines, at a distance of 1-foot from the property line.
1. Construct alleys, driveways and approaches six (6) inches thick. Construct the width of the driveways and driveway approaches as shown on the Plans or as directed by the ENGINEER.
- B. Removal of Existing Curb for Sidewalk Ramps and Driveway Approaches: Conform construction of sidewalk ramps within street intersections where curbed pavement existing to the current FDOT Roadway and Traffic Design Standards.
1. Saw cut, to full depth of pavement, and remove a minimum of an 18-inch wide curb and gutter section where there is no proper curb drop for the sidewalk ramp or driveway approach. When mountable curbs are present, remove a 24-inch wide curb and gutter section for the construction of sidewalk ramps, as specified above.
 2. Remove curb and gutter as determined by the ENGINEER in the field but remove curb and gutter at least as wide as the proposed sidewalk ramp plus 1-foot on each side.

3. Replace the removed curb and gutter section with materials, equal to what was removed and seal joint with hot poured rubber asphalt.
- C. Install 5/8-inch diameter self-tapping hook bolts, in the existing concrete pavement as indicated on the Plans prior to placing concrete for the removed curb and gutter section.
- D. Placement of Forms: Use wood forms, straight and free from warp, of nominal depth for sidewalk sections less than 25 feet in length.
1. Stake forms to line and grade in a manner that will prevent deflection and settlement.
 2. When unit slab areas are to be poured, place slab division forms such that the slab division joints will be straight and continuous.
 3. Set forms for sidewalk ramps to provide a grade toward the centerline of the right-of-way in accordance with current standards. Use a uniform grade, except as may be necessary to eliminate short grade changes.
 4. Oil forms before placing concrete. Leave forms in place at least 12 hours after the concrete is placed. Place forms ahead of the pouring operations to maintain uninterrupted placement of concrete.
 5. The use of slip form pavers can be allowed when approved by the ENGINEER in lieu of the construction system described above.
- E. Joints: Construct transverse and longitudinal expansion and plane-of-weakness joints at the locations specified herein, or as indicated on the Plans or as directed by the ENGINEER.
1. Place the transverse expansion joints for the full width and depth of the new work. Use transverse expansion joints placed against an existing pavement a minimum of six (6) inches deep but no less than the thickness of the concrete being placed.
 2. Conform longitudinal expansion joints to the requirements as transverse expansion joints.
 3. Construct joints true to line with their faces perpendicular to the surface of the sidewalk. Install the top slightly below the finished surface of the sidewalk. Construct transverse joints at right angles to the centerline of the sidewalk and construct longitudinal joints parallel to the centerline or as directed by the ENGINEER.
 4. Place transverse expansion joints, 1/2-inch thick, through the sidewalk at uniform intervals of not more than 50 feet and elsewhere as shown on the Plans, or as directed by the ENGINEER.

5. Place expansion joints, 1/2-inch thick, between the sidewalk and back of abutting parallel curb, buildings or other rigid structures, concrete driveways and driveway approaches. When directed by the ENGINEER, place the expansion joint between sidewalks and buildings 1-foot from the property line and parallel to it.
 6. Form plane-of-weakness joints every five (5) feet. Form joints by use of slab divisions forms extending to the full depth of the concrete or by cutting joints in the concrete, after floating, to a depth equal to 1/4 the thickness on the sidewalk. Construct cut joints not less than 1/8-inch or more than 1/4-inch in width and finish smooth and at right angles to the centerline on the sidewalk.
- F. Placing and Finishing Concrete: Place all concrete on a prepared unfrozen, smooth, leveled, rolled and properly compacted base. Place concrete on a moist surface with no visible water present.
1. Deposit the concrete, in a single layer to the depth specified. Spade or vibrate and compact the concrete to fill in all voids along the forms and joints. Strike off the concrete with a strike board until all voids are removed and the surface has the required grade and cross section as indicated on the Plans, or as directed by the ENGINEER.
 2. Float the surface of the concrete just enough to produce a smooth surface free from irregularities. Round all edges and joints with an edger having a 1/4-inch radius.
 3. Broom the surface of sidewalks, driveways and approaches to slightly roughen the surface.
 4. Texture the surface of the sidewalk ramps with a coarse broom transversely to the ramp slope, and coarser roughen than the remainder of the sidewalk. Contrast the ramp slope in color (using a brick-red dye or approved equal) from the remainder of the sidewalk. Comply with minimum color contrast and slope requirements from FAC, UFAS, ADAAG, Local Government Standards, or as directed by the ENGINEER.
- G. Curing: After finishing operations have been completed and immediately after the free water has left the surface, completely coat and seal the surface of the concrete (and sides if slip-forming is used) with a uniform layer of white membrane curing compound. Do not thin the curing compound. Apply the curing compound at the rate of one gallon per 200 square feet of surface.
- H. Barricades: Place suitable barricades and lights around all newly poured sidewalks, sidewalk ramps, driveways, driveway approaches and curb and gutter sections in order to protect the new work from damage from pedestrians, vehicles and others until the concrete has hardened.

1. Leave barricades in place for a minimum of two (2) days, except for driveway approaches and curb and gutter sections. Leave barricades in place for a minimum of three (3) days.
2. Remove and replace any concrete that suffers surface or structural damage at no additional cost.

I. Protection:

1. Against Rain: Protect new concrete from the effects of rain before the concrete has sufficiently hardened. Have available on the job site at all times enough burlap or 6-mil thick polyurethane film to cover and protect one day's work. Stop work and cover completed work when rain appears eminent. As soon as the rain ceases, uncover the concrete and burlap drag the surface where necessary. Apply curing compound to any areas where the compound has been disturbed or washed away.
2. Against Cold Weather: If concrete is placed between December 15 and February 15, have available on the site sufficient amount of clean, dry straw or hay to cover one (1) day's production. If the temperature reaches 40 degrees F and is falling, place the hay or straw 12 inches thick, immediately after the curing compound is applied.
3. Concrete Temperature Limitations: Do not place concrete when the temperature of the concrete at the point of placement is above 90 degrees F.

J. Cleanup: After the concrete has gained sufficient strength, but no sooner than within 12 hours, remove the fixed forms and backfill the spaces on both sides with sound earth of topsoil quality. Compact, level and leave backfill in a neat condition.

K. Gutters and Curbs: Construct gutters and curbs in accordance with Section 520 FDOT Standard Specifications for Road and Bridge Construction, latest edition, including supplements.

3.4 FIELD QUALITY CONTROL

- A. Concrete Delivery Ticket: Use a ticket system for recording the transportation of concrete from the batching plant to point of delivery. Issue this ticket to the truck operator at the point of loading and give to the ENGINEER upon delivery.
- B. Concrete Delivery Rejection: Remove concrete not permitted for inclusion in the work by the ENGINEER from the site. Rejection of concrete will be determined through Field Quality Control and elapsed time from mixer charging to delivery.
- C. Concrete Testing at Placement: Perform tests of each batch of concrete delivered, each 50 cubic yards, or whenever consistency appears to vary. The

sampling and testing of slump, air content and strength will be performed at no cost to the CITY.

1. Sampling: Secure composite samples in accordance with the Method of Sampling Fresh Concrete, ASTM C172.
2. Slump Test: Test in accordance with ASTM C143. Use the least slump possible consistent with workability for proper placing of the various classifications of concrete.
 - a. Place structural concrete for walls and slabs, by means of vibratory equipment, with a slump of four (4) inches.
 - b. A tolerance of up to 1-inch above the indicated maximum will be allowed for individual batches provided the average for all batches or the most recent ten (10) batches tested, whichever is fewer, does not exceed the maximum limit.
3. Air Content: Determine air content of normal weight concrete in accordance with Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method, ASTM C23 1, or by the volumetric method, ASTM C 173, for each strength test.
4. Compressive Strength: Make two (2) strength tests of three (3) samples each for each 50 cubic yards, or fraction thereof, of each mix design of concrete placed in any one (1) day.
 - a. Handling Samples: Mold and cure three (3) specimens from each sample in accordance with Method of Making and Curing Concrete Test Specimens in the Field, ASTM C31. Record any deviations from the requirements of this Standard in the test report.
 - b. Testing: Test specimens in accordance with Method of Test for Compressive Strength of Cylindrical Concrete Specimens, ASTM C39. Test one (1) specimen at seven (7) days for information and test two (2) at 28 days for acceptance. Use the average of the strengths of the two (2) specimens tested at 28 days. Discard results if one (1) specimen in a test manifests evidence of improper sampling, molding or testing, and use the strength of the remaining cylinder. Should both specimens in test show any of the above defects, discard the entire test.
 - c. Acceptance of Concrete: The strength level of the concrete will be considered satisfactory so long as the averages of all sets of three consecutive strength test results equal or exceed the specified 28-day strength and no individual strength test results falls below the specified 28-day strength by more than 500 psi. If the strength test is not acceptable, perform further testing to qualify the concrete.

- d. Concrete Temperature: Determine the temperature of concrete sample for each strength test.
- D. Reductions due to deficiencies in thickness or compressive strength are additive, that is, if an area is deficient by 3/8 inch and under strength by 200 psi, the total reduction is 20% plus .02% or .40% reduction.

END OF SECTION

SECTION 323113
CHAIN LINK FENCING AND GATES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for providing vinyl coated galvanized steel chain link fencing and gates.
- B. Related Work Specified in Other Sections Includes:
 - 1. Section 033100 – Concrete, Masonry, Mortar and Grout

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. ASTM 1043 - Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework
 - 2. ASME B36.10M - Welded and seamless wrought steel pipe
 - 3. FS RR-F-191 - Fencing, Wire and Post, Metal

1.3 DESIGN

- A. General: Provide fencing of the chain-link type and six (6) feet high with six (6) feet of diamond mesh woven wire fabric. Locate the fence as shown.
- B. Fabric, Supports and Fittings: Provide steel fabric, supports and fittings except as specified.
- C. Fabric, Supports and Fittings: Provide green or black color coated steel fabric, supports and fittings. Coat the framework, posts and hardware except hinges and latches to match the fabric with thermoplastic or thermoset resins and provide oven-baked materials to a minimum dry coating of seven mils. Color coat all accessories except hinges and latches to match the fence. Provide aluminum hinges and latches.
- D. Pipe Sizes and Weights: Provide pipe sizes and weights meeting the requirements of ASME B 36.10, Table 2 and ASTM A 53, Table 1. All pipe sizes listed are nominal, unless otherwise indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturers are listed in the County Approved Product List, Appendix F. Other manufacturers of equivalent products may be submitted.

2.2 FABRIC

- A. Provide fabric that is a one piece woven 2-inch mesh chain link of 6-gauge steel wire with a minimum breakload of 1800 lbs/ft. and which is interwoven to form a continuous fabric with no splices and is coated after weaving. Provide the top selvage knuckled for fabric 60 inches high and under, and the bottom selvage twisted and barbed for fabric over 60 inches high. Clean the fabric of all grease and foreign matter before coating and shipping. Stretch the fabric tightly approximately three inches above grade level and attach the fabric to the terminal or gateposts using beveled tension bands and tension bars.
 - 1. Provide galvanized fabric that is fusion coated with a minimum seven-mil coating of polyvinyl chloride (PVC) applied over a thermoset plastic bonding agent. Conform the PVC to Federal Specification RR-F-191.
 - 2. Vinyl coat all cut ends.
 - 3. Conform aluminum fabric to Fed. Spec. RR-F-191.

2.3 TENSION WIRE

- A. For the tension wire for the fence bottom use minimum 6-gauge galvanized coil spring steel fusion color coated as specified for the fabric.

2.4 TOP AND BRACE RAILS

- A. General: Furnish the top rail in approximately 20-foot lengths with couplings approximately 6 inches long for each joint. Provide one coupling in each 5 with an expansion spring. Provide the rail continuous from end-to-end for each run of fence. Provide brace rails at all terminal posts, locate the rails midway between the top and bottom of the fabric and extend from the terminal post to the first adjacent line post. Securely fasten rails at both ends. Provide top and brace rails that are galvanized steel fusion color coated as specified for framework in Subsection 1.03 C.
- B. Pipe Type: 1-1/4-inch, Schedule 40 pipe or a 1.625- by 1.25-inch roll-formed section with minimum bending strength of 192 pounds on 10-foot span.

2.5 POSTS

- A. General: Provide all posts that are coated as specified for vinyl-coated framework, posts and hardware in Subsection 1.03 C.

B. Pipe Posts: Provide pipe posts as follows:

1. For end, corner and pull posts use 2-1/2-inch, Schedule 40 pipe
2. For line posts use 2-inch, Schedule 40 pipe
3. For gate posts use the following pipes for different leaves:
 - a. For leaves up to 6 feet wide, use 2-1/2-inch Schedule 40 pipe
 - b. For leaves over 6 feet to 12 feet wide, use 3-1/2-inch Schedule 40 pipe
 - c. For leaves over 12 feet to 18 feet wide, use 6-inch Schedule 40 pipe

C. Bending Strength: Provide materials with the minimum bending strength based on a 6-foot cantilever for rolled formed or tube posts as follows:

		Galvanized Steel
1. End, Corner and Pull Posts:		
	2.875" O.D. roll formed or	444
	2-1/2-inch square tube	547
	2-1/2-inch square, heavy wall extrusion	
2. Line Posts:		
	For fences 8 feet maximum height 1.875- by 1.625-inch C-Section	245
	For fences over 8 feet high 2.25- by 1.703-inch C-Section	347
3. Gate Posts:		
	For leaves up to 6 feet wide (2.875-inch O.D. roll formed or	444
	2-1/2-inch square tube	645

2.6 GATES

- A. General: For the perimeter construction of gates with leaves up to 6 feet wide, use 1-1/2-inch Schedule 40 pipe or 1-1/2-inch square steel tube, and for gates with leaves greater than 6 feet wide, use 2-inch Schedule 40 pipe or 2-inch square steel tube.
- B. Braces: Provide the gates with sufficient horizontal and vertical members and bracing to ensure structural stability to prevent sagging and to provide for the attachment of fabric, hardware and accessories. Provide gates with diagonal cross bracing consisting of 3/8-inch diameter adjustable length truss rods where necessary to provide frame rigidity without sag or twist.
- C. Cantilever Sliding Gates: Furnish cantilever overhang as follows:

Gate Leaf Size	Overhang
6'-0" to 10'-0"	6'-6"
11'-0" to 14'-0"	7'-6"
15'-0" to 22'-0"	10'-0"
12'-0" to 30'-0"	12'-0"

- 1. For gates leaf sizes 23'-0" to 30'-0", add one additional 2-inch square lateral support rail welded adjacent to the top horizontal rail. Make the bottom rail of 2" x 4" tubing weighing 1.71 pounds per foot.
- 2. Provide all cantilever overhang frames having 3/8-inch (galvanized steel) (aluminum) brace rods.
- 3. Provide the enclosed track made of a combined track and rail aluminum extrusion having a total weight of 3.72 pounds per foot and designed to withstand a reaction load of 2,000 pounds.
- 4. Provide each gate leaf with two swivel type zinc die cast trucks having four sealed lubricant ball-bearing wheels, 2-inch in diameter by 9/16-inch in width, with two side rolling wheels to insure alignment of the truck in the track. Hold trucks to post brackets by 7/8-inch diameter ball bolts with 1/2-inch shank. Design truck assemblies to take the same reaction load as the track.
- 5. Install gates on 8.625-inch OD Schedule 40 (galvanized)) posts. Use three posts for single slide gate and four posts for double slide gate.
- 6. Provide guide wheel assemblies for each supporting post. Provide each assembly consisting of two rubber wheels 4 inches in diameter attached to a post so that the bottom horizontal member will roll between the wheels which can be adjusted to maintain gate frames plumb and in proper alignment.

- D. Gate Accessories: Equip gates with hinges, latches, center stops, hasps, holdbacks, and padlocks. Provide hinges, latches, center stops, hasps, and holdbacks that are aluminum. Provide double gates with a center drop bar and gate holdbacks.
- E. Latches: Provide gate latches that are positive locking, pivoting type with the padlocking arrangement accessible from either side of the gate.
- F. Hinges: Hang all gates on offset hinges to permit swinging the gate through a 180-degree arc to lie, when not obstructed, along and parallel to the line of the fence.

2.7 ATTACHMENTS

- A. General: Provide all attachments fabricated of coated to match the fabric as specified for framework, posts and hardware in Subsection 1.03, except provide aluminum hinges and latches.
- B. Tension Bars: Provide 3/16-inch by 3/4-inch galvanized carbon steel tension bars attached to the terminal posts by means of beveled edge bands.
- C. Truss Rods: Provide 3/8-inch diameter galvanized carbon steel truss rods. Securely mount truss rods between the line post end of the brace rail and the base of the terminal post.
- D. Post Tops: Provide post tops of galvanized pressed steel or malleable iron to form weathertight caps for post or tube posts. Make provisions for installation or passage of the top rail.
- E. Brace and Tension Bands: Provide galvanized steel brace bands and tension bands, of the "unclimbable" beveled edge type with 3/8-inch diameter square shouldered aluminum carriage bolts, nonremovable from outside of the fence.
- F. Rail Couplings: Provide rail couplings of the outside sleeve type, not less than six inches long, self-centering, which allows for expansion and contraction. Provide aluminum galvanized steel rail couplings.
- G. Fabric Ties: Provide 9-gauge galvanized steel fabric ties.
- H. Hog Rings: Provide 9-gauge wire, aluminum alloy, Type 6061-T6 hog rings.
- I. Extension Arms: Provide galvanized pressed steel extension arms for supporting the barbed wire where used. Design the arms with an adequate cross section to withstand without failure or permanent deflection a perpendicular force of 250 pounds applied at the end of the arm when the arm is securely attached to the post. Construct extension arms to be slanted out.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install all fencing and accessories according to the manufacturer's recommendations. Do not begin installation and erection before final grading is completed, unless otherwise approved.
- B. Excavation: Drill or hand excavate (using post hole digger) holes for posts to the diameter and spacing indicated, in firm, undisturbed or compacted soil.
 - 1. If not indicated, excavate holes for each post to the minimum diameter recommended by the fence manufacturer, but not less than four times the largest cross-section of the post.
 - 2. Unless otherwise indicated excavate the hole depths approximately 3 inches lower than the post bottom, with the bottom of posts set not less than 36 inches below the finished grade surface.
- C. Tension Wire: Attach the tension wire to the bottom of the fabric by hog rings spaced at 24-inch intervals and to terminal posts by brace bands.
- D. Posts: Set posts plumb in concrete encasement at not more than 10-foot centers in the line of the fence with the tops properly aligned. Extend concrete encasement for line posts a minimum of three feet below finish grade with a minimum diameter of ten inches. Extend concrete encasement for terminal, corner and gate posts 40 inches below finished grade, except gate posts for leaves greater than 6 feet, for which extend the encasement 54 inches below grade. Provide the minimum diameter of encasement for terminal, corner and gateposts to be sufficient to provide not less than four inches between any part of the post and the face of the concrete and in no case provide the diameter to be less than 12 inches. Set line posts 32 inches into the concrete and set all other posts 36 inches, except gate posts for leaves greater than 6 feet wide, which are to be set 48 inches into the concrete. Slope the top exposed surface of the concrete to shed water and provide a neat appearance.
 - 1. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment and hold posts in position during placement and finishing operations.
 - a. Unless otherwise indicated, extend the concrete footing 2 inches above grade and trowel to a crown to shed water.
 - 2. Where aluminum is in contact with concrete, coat the aluminum.
- E. Fabric Ties: Space fabric ties approximately 12 inches apart on the line posts and 12 inches apart on the rails. (For clips used with C-section posts, use galvanized 11-gauge steel wire.)

- F. Fabric: Leave approximately 3 inches between finished grade and the bottom selvage, unless otherwise indicated. Pull the fabric taut and tie to posts, rails, and tension wires. Install the fabric on the security side of the fence, and anchor the fabric to the framework so that the fabric remains in tension after the pulling force is released.
- G. Fasteners: Install nuts for tensions bands and hardware bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent nut removal.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 329200

RESTORATION BY SODDING OR SEEDING

PART 1 GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

- A. The work in this section consists of furnishing all labor, material and equipment to restore all areas disturbed during construction to match preconstruction conditions. Establish a stand of grass within the areas disturbed by furnishing and placing grass sod where required, or by seeding and mulching areas not requiring sod.

1.2 REFERENCE DOCUMENTS

- A. Use materials conforming to the requirements of Florida Department of Transportation Standard Specifications for Road and Bridge Construction as follows:
 - 1. Section 570 – Grassing (by Seeding)
 - 2. Section 575 – Sodding
 - 3. Section 981 – Grassing and Sodding Materials
 - 4. Section 982 – Commercial Fertilizer
 - 5. Section 983 – Water for Grassing

1.3 SUBMITTALS

- A. Submit certifications and identification labels for all sodding supplied in accordance with General Conditions.

PART 2 PRODUCTS

2.1 SODDING

- A. Types: Sod may be of either St. Augustine or Argentine Bahia grass or as that disturbed, as established prior to construction. Use well matted sod with roots. When replacing sod in areas that are already sodded, use sod of the same type as the existing sod.

- B. Provide sod as required in accordance with Florida Department of Transportation Specifications 575 and 981. Furnish sod equal to and similar in type as that disturbed. Place and water in accordance with FDOT Specifications Section 575.
- C. Use sod in commercial-size rectangles, preferably 12-inch by 24-inch or larger, except where 6-inch strip sodding is called for.
- D. Use sod that is sufficiently thick to secure a dense stand of live grass. Use sod that is live, fresh and uninjured at the time of planting, having a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling. It shall be reasonably free of weeds and other grasses. Plant sod as soon as possible after being dug, and shade and keep moist from the time it is dug until it is planted.
- E. Handle sod in a manner to prevent breaking or other damage. Do not handle by dumping from trucks or other vehicles. Use care at all times to retain the native soil on the roots of each sod roll during stripping and handling. Sod that has been damaged by handling during delivery, storage or installation will be rejected.
- F. Swales: Place sod to the proper grade and cross section in all flow areas to ensure the design flow of water in the ditch. In excavating for the placement of sod, provide a minimum of 3 inches of undercut.

2.2 FERTILIZER

- A. Supply chemical fertilizer in suitable bags with the net weight certification of the shipment. Fertilizer shall be 12-8-8 and comply with Section 982 of the FDOT Standard Specification for Road and Bridge Construction.
- B. The numerical designations for fertilizer indicate the minimum percentages (respectively) of (1) total nitrogen, (2) available phosphoric acid and (3) water soluble potash, contained in the fertilizer.
- C. The chemical designation of the fertilizer shall be 12-8-8, with at least 50 percent of the nitrogen from a nonwater-soluble organic source. The nitrogen source may be a ureaformaldehyde source provided it is not derived from a waste product of the plastic industry.

2.3 EQUIPMENT

- A. Spread fertilizer uniformly at the specified rate.

2.4 NETTING

- A. See County Approved Product List, Appendix F.

2.5 SEEDING

- A. Seed all unpaved areas disturbed during construction that do not require sod. Complete all seeding in conformance with FDOT Specifications Sections 570 and 981. Mulch and fertilize the grassed areas shall be mulched and fertilized in accordance with FDOT Specifications.
- B. Provide mulch material free of weeds. Mulch shall be oat straw or rye, Pangola, peanut, Coastal Bermuda, or Bahia grass hay.
- C. All seeds must have been tested within 6 months of planting. Submit a seed bag tag with final payment requests from each type or mixture of seed used.

2.6 TOPSOIL

- A. Topsoil stockpiled during excavation may be used. If additional topsoil is required to replace topsoil removed during construction, it shall be obtained off site at no additional cost to the COUNTY. Topsoil shall be fertile, natural surface soil, capable of producing all trees, plants, and grassing specified herein.

2.7 MULCH

- A. Furnish small grain straw mulch. Apply mulch at a rate of 1.5 tons per acre, corresponding to a depth not less than 1-inch or more than 3-inches according to texture and moisture content of mulch material. Apply asphalt emulsion at a rate of 150 gallons per ton of straw to anchor the straw applied.

2.8 WATER

- A. It is the CONTRACTOR'S responsibility to supply all water to the site, as required during seeding and sodding operations and through the maintenance period and until the work is accepted. Make whatever arrangements may be necessary to ensure an adequate supply of water to meet the needs for the work. Furnish all necessary hose, equipment, attachments, and accessories for the adequate irrigation of lawns and planted areas as may be required. Water shall be suitable for irrigation and free from ingredients harmful to plant life.

2.9 SOIL IMPROVEMENTS

- A. Apply lime at the rate of 1 to 1.5 tons per acre. Apply 10-10-10 commercial fertilizer at the rate of 800 pounds per acre and work well into the top inch of topsoil.

PART 3 EXECUTION

3.1 SOD BED PREPARATION

- A. Clear areas to be sodded and/or seeded of all rough grass, weeds, and debris, and bring soil to an even grade.
- B. Thoroughly till soil to a minimum 4-inch depth.
- C. Bring area to proper grade, free of sticks, stones, or other foreign matter over 1-inch in diameter or dimension. The surface shall conform to finish grade, less the thickness of sod, free of water-retaining depressions, the soil friable and of uniformly firm texture.

3.2 INSPECTION

- A. Verify that soil preparation and related preceding work has been completed.
- B. Do not start work until conditions are satisfactory.

3.3 SOD HANDLING AND INSTALLATION

- A. During delivery, prior to planting, and during the planting of sod areas, protect the sod panels at all times from excessive drying and unnecessary exposure of the roots to the sun. Stack sod during construction and planting so as not to be damaged by sweating or excessive heat and moisture.
- B. After completion of soil conditioning as specified above, lay sod panels tightly together so as to make a solid sodded lawn area. On mounds and other slopes, the long dimension of the sod shall be laid perpendicular to the slope. Immediately following sod laying, roll the lawn areas with a lawn roller customarily used for such purposes, and then thoroughly water.
- C. Place sod at all areas where sod existed prior to construction, on slopes of 3 horizontal to 1 vertical (3:1) or greater, in areas where erosion of soils will occur, and as directed by the ENGINEER. On areas where the sod may slide, due to height and slope, the ENGINEER may direct that the sod be pegged, with pegs driven through the sod blocks into firm earth, at suitable intervals.

3.4 USE OF SOD ON ROADWAY PROJECTS

- A. In accordance with the FDOT District One Standard Practice, establish permanent green grass at the completion of roadway construction and maintenance work. The following shall apply to all restoration involving State or County roadways:
 - 1. Use sod in lieu of seed and mulch on all roadways with urban (raised curb) typical sections.

2. One inch water per week shall be required for a minimum of four (4) consecutive weeks for the purpose of establishing sod. This can be waived during construction, if and only if there is a minimum of one inch of rain per week on all sod on the project.
3. Placed sod on slopes 1:3 or greater. Stake sod on slopes 1:2 or greater.
4. On all curves with superelevation, place sod from the edge of pavement to the toe of slope on the downhill side(s) for the entire length of the superelevated roadway. On multi-lane divided rural facilities, place sod in the median and on the inside of the curve in the superelevated areas. This does not apply to reverse crowns.
5. Use sod for all projects with less than 10,000 square yards grass area.
6. On tangent sections and on outside of curves, use sod between the edge of pavement and a point 4 feet beyond the shoulder break point.
7. The entire width of sod should not exceed 15 feet from the edge of pavement.
8. Sod is to be used to eliminate narrow seed and mulch areas. Sod areas less than 6 feet in width.
9. Place sod around drainage structures as per the standard Indexes and extend to the edge of pavement.

3.5 SOD MAINTENANCE

- A. The sod shall produce a dense, well-established growth. Repair and re-sod all eroded or bare spots until project acceptance. Repair to sodding shall be accomplished as in the original work.
- B. Perform sufficient watering to maintain adequate moisture for optimum development of the seeded and sodded areas, and no less than 1.5 inches of water per week for at least 2 weeks. Thereafter, apply water for a minimum of 60 days as needed until the sod takes root and starts to grow or until final acceptance, whichever is latest.

3.6 GUARANTEE

- A. Guarantee a live and vigorous stand of permanent grass at the time of acceptance of the work consisting of 80 percent minimum coverage for seeded grass areas with no bare spots greater than 5 square feet.

3.7 CLEANING

- A. Remove debris and excess materials from the project site.

END OF SECTION

SECTION 330130.16

TELEVISIONING AND INSPECTION OF GRAVITY SEWER SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. Work specified herein:

1. Furnish all labor, tools, test equipment and materials, including any and all permits required to televise, inspect, video, still photograph and document the gravity wastewater collection systems.

1.2 QUALITY ASSURANCE

- A. Utilize services of competent personnel in the field of video inspection of wastewater collection systems.
- B. Schedule all work with ENGINEER.
- C. Equipment used shall be in good working order and provide continuous operation during video inspection.
- D. Video recording media shall be of good visual quality capable of slow motion and pausing without significant reduction of visual quality.

1.3 SUBMITTALS

- A. Submit to the County Manager or designee a list of equipment and materials to be used on the project, including all permits obtained prior to commencing with the Work.
- B. Engineer of Record shall certify and submit Submit to the County Manager or designee a copy of all television inspection log sheets and video recording media completed.

PART 2 MATERIALS

2.1 GENERAL

- A. Equipment used shall be designed for use in gravity wastewater collection systems. CONTRACTOR has the option of a County approved equal device or other material than that which is specified. Submittals are required prior to commencement of work.

2.2 TELEVISION CAMERA

- A. Camera used shall be 360-degree COLOR RVC camera. Camera shall be operative in 100% relative humidity and be specifically designed for the environment. Camera shall have an integral lighting system capable of producing clearly focused, well-defined images of the entire periphery of the pipe. Camera shall have an integral depth measurement device capable of clearly showing the depth of vertical dips. The quality of video picture and definition provided shall be to the satisfaction of the ENGINEER and, if unsatisfactory, equipment shall be removed and replaced with satisfactory equipment.

2.3 MONITOR

- A. High resolution video shall be used. Quality of video shall be to the satisfaction of the County Manager or designee.

2.4 VIDEO VERIFICATION EQUIPMENT

- A. Furnish video equipment to provide a visual and audio recording of all areas in the pipe. Video system at the site shall be capable of rewind, play back, slow motion and stop motion. The video shall be equipped with an audio channel for clearly recording the camera locations and operator observations (cracks, leaks, service connections, etc.). The system shall continuously indicate distance, in feet, from manhole to manhole and the manhole-to-manhole run numbers on the video recording.

2.5 WINCHES

- A. Furnish variable speed powered remote controlled winches for upstream and downstream manhole locations to control two-way movement of the camera. If a self-propelled camera is used, winches are not necessary.

2.6 POWER SUPPLY

- A. Power supply shall be continuous. If night operations occur, supply all labor, power and lighting equipment for operations, traffic safety, permits, etc.

PART 3 EXECUTION

3.1 GENERAL

- A. All sanitary sewer gravity lines shall be televised at the CONTRACTOR's expense. A video of the subject mains shall be provided prior to final acceptance. Televiewing may only occur after the stabilized subgrade has been installed and satisfactory density tests have been submitted to Collier County Utilities. The sewer video inspection shall include rotating the camera lens to inspect the interior of each sewer lateral.

- B. Demonstrate the ability of the TV/video equipment (camera/light/video/audio/ photograph system) to the satisfaction of the County Manager or designee. Distance meter shall be furnished on the video recording. Meter shall be checked using distances between manholes. Meter distances and actual distances shall be consistent. Depth measurement device shall be visible in the video recording during movement of the camera in the pipe.

3.2 TELEVISION/INSPECTION

- A. Inspection shall be done one manhole section at a time. Stop flow into the section being inspected prior to video inspection, unless otherwise approved in writing by the County Manager or designee.
- B. Locate video vehicle on upstream side of manhole. Video in the downstream direction such that camera movement is with the flow.
- C. Insert the camera in the upstream manhole after flow restrictions required have been accomplished. Flow into the system being inspected shall be stopped, with the exception of service laterals into the system being inspected. Move camera through the pipelines at a moderate speed not exceeding 30 feet per minute. Stop camera at locations where one or more of the following conditions is observed:
 - 1. Infiltration/inflow sources.
 - 2. Service Laterals.
 - 3. Structural defects including broken pipe; collapsed or collapsing pipe, cracks, deterioration, punctures, etc.
 - 4. Abnormal joint conditions such as misalignments, open joints and joints not sealed.
 - 5. Unusual conditions such as root intrusion, protruding pipes, in-line pipe size changes, mineral deposits, grease and obstructions.
- D. Stop camera long enough for a thorough visual inspection of the conditions. All such conditions as specified above shall be audio recorded on video and the inspection log sheet. Move the camera and rotate to obtain optimum view of the conditions. If requested by the County Manager or designee, view problem areas in the opposite direction by pulling the video camera from the opposite direction at no additional cost to the COUNTY.
- E. While the camera is stopped at each service connection, rotate the camera so as to be able to view the service connection for a length of time that enables a good visual inspection of the service connection for damage and infiltration. Be responsible for measurements such as service lateral locations, if used for subsequent rehabilitation work.

- F. When, during the inspection operation, the television camera will not pass through the entire manhole-to-manhole section, set up equipment so that the inspection can be performed from the opposite manhole at no additional cost to the COUNTY.
- G. Prior to the final acceptance, all manholes shall be televised and inspected. The complete interior of each manhole shall be inspected and video recorded after the interior coating has been completed. Manhole identification numbers shall be displayed on the video recording, and the recording shall accompany the submittal of the gravity lines inspection. Any deficiencies shall be corrected prior to acceptance by the County.

3.3 DOCUMENTATION

- A. Furnish a detailed report and video of the system inspected. The minimum information supplied shall be the following:
 - 1. Name and address of CONTRACTOR and the ENGINEER.
 - 2. Name of OWNER, system(s) inspected, and OWNER's representative involved.
 - 3. Log reports:
 - a. Log sheet for each section of pipe
 - b. Separate line for each deficiency and location
 - c. Corresponding video and location of each section of pipe and deficiencies on video.
 - 4. Video shall be labeled with the following information:
 - a. System that is video recorded (street name and manhole to manhole numbers) and log report number corresponding to video
 - b. Date video was recorded
 - c. CONTRACTOR's name and representative
 - d. OWNER's name
- B. All videos shall be rendered unable to be taped over after they are completed.

3.4 MAINTENANCE OF TRAFFIC

- A. Be responsible for all maintenance of traffic around work site. CONTRACTOR shall maintain traffic in accordance to all federal, state and local regulations. At no additional cost to the COUNTY, submit a Maintenance of Traffic Plan, for review and approval by Collier County DOT as necessary, prior to commencing work. Obtain all necessary permits prior to commencing work, at no additional cost to the COUNTY.
- B. MOT shall also include construction and maintenance of any necessary detour facilities, furnishings, installing and maintaining of traffic control and safety devices during construction, control of dust, and any other special requirements for safe and expeditious movement of traffic around or through the work site.
- C. Be responsible for coordination with all affected agencies when roadways will be closed or traffic will be detoured. No detours or roadway closings shall be permitted unless specifically approved in writing by the County Manager or designee or ENGINEER.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 330201

ROADWAY CROSSINGS BY OPEN CUT

PART 1 GENERAL

1.1 SCOPE OF WORK

Provide all labor, materials, equipment, supervision and incidentals required to install the pipeline as shown on the Drawings in Collier County Streets by method of open cut.

Note: Open cutting of existing pavement will generally not be allowed, but may be considered under one or more of the following conditions:

1. Subsurface obstructions including rock;
2. Extreme high water table;
3. Limited space for jack and bore pits;
4. Condition of roadway surface - including imminent resurfacing and rebuilding, provided inspection and approval beforehand is made by the affected Transportation Department; or
5. Extreme economic hardship is proven with adequate supportive data.

1.2 SUBMITTAL

- A. Submit shop drawings to the ENGINEER for review.
- B. Before starting work, submit to the Collier County Department of Transportation, with copy to the ENGINEER, a detailed schedule of his operations a minimum of fourteen (14) days prior to beginning work for approval. This shall include, but not be limited to, type and extent of temporary paving, and drawings and lists describing materials and traffic control methods to be used. Approval shall not relieve the CONTRACTOR of his obligation to provide a safe and proper crossing.
- C. If a detour is required, submit a traffic control plan for approval to Collier County and/or the Florida Department of Transportation.
- D. Submit a plan for maintenance of traffic in accordance with Index 600 through 650 of the Florida Department of Transportation Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Use materials specified in other applicable portions of this Specification.

PART 3 EXECUTION

3.1 GENERAL

- A. Trench dimensions for open cutting of road crossings are shown on the Standard Details.
- B. Where possible, limit the completion of the open-cut road crossing to a 24-hour period. Perform all work in accordance with the approved traffic control plan.
- C. Notify Collier County DOT forty-eight (48) hours in advance of starting construction.

3.2 INSTALLATION

A. Temporary Roadways

1. For temporary roadways required for traffic relocation use materials meeting the requirements of the FDOT. Use temporary roadways when crossing a state highway right-of-way or at the direction of the ENGINEER.
2. Maintain temporary roadways in good condition throughout their use.
3. Maintain drainage through all existing ditches by the use of culvert pipe as necessary.
4. Submit drawings indicating the type and location of temporary roadways for approval prior to beginning work.
5. Provide all necessary barricades and signs where detours are permitted as required to divert the flow of traffic. Notify Collier County DOT and ENGINEER in advance of planned detours. While traffic is detoured, expedite construction operations to minimize the period of detour.
6. Perform and complete all work at the roadway crossing in a manner fully satisfactory to Collier County DOT.

B. Maintenance of Traffic

1. The requirements specified herein are in addition to the plan for Maintenance of Traffic as specified in Section 015526.

2. Furnish during construction and any subsequent maintenance within State secondary road right-of-ways and Collier County streets, proper signs, signal lights, flagmen, and other warning devices for the protection of traffic all in conformance with the latest Manual on Uniform Traffic Control and Safe Streets and Highways, and the Florida Manual of Traffic Control and Safe Practices for Street and Highway Construction, Maintenance and Utility Operations. Information as to the above may be obtained from FDOT Division engineers. The ENGINEER, County Engineer, or FDOT Manager of the right-of-way of their representatives reserves the right to stop any work for non-compliance.
3. Take precautions to prevent injury to the public due to open trenches. Night watchmen may be required where special hazards exist, or police protection provided for traffic while work is in progress. Be fully responsible for damage or injuries whether or not police protection has been provided.
4. Unless permission to close a County street is received in writing from the proper authority, place all excavated material so that vehicular and pedestrian traffic may be maintained at all times. Repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the ENGINEER if the CONTRACTOR's operations cause traffic hazards.
5. Be fully responsible for the installation of adequate safety precautions, for maintenance of the channelization devices, and for the protection of the traveling public.
6. Maintain at all open cut crossings, a minimum of one-way traffic during the daylight hours, and two-way traffic at night.

C. Installation of Pipeline

1. Meet the requirements of the applicable portions of this specification for pavement removal, sheeting, shoring and bracing, excavation and backfill, and dewatering.
2. Install the pipe in accordance with Division 2 of these Specifications.
3. Backfill the trench in accordance with the requirements of Section 312323.
4. Replace pavement in accordance with the requirements of Section 320117.

END OF SECTION

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SECTION 330502

HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install High Density Polyethylene (HDPE) pressure pipe, fittings, and appurtenances as shown on the Drawings and specified in the Contract Documents.
- B. High Density Polyethylene (HDPE) – Collier County Utilities has the option of approving the use of HDPE for pipeline crossings of roadways, ditches, canals, and environmentally sensitive lands. HDPE mains shall have the same equivalent internal diameter and equivalent pressure class rating as the corresponding PVC pipe, unless otherwise approved by the County Manager or designee. For all roadway crossings requiring casing pipe, a steel or DR 11 HDPE casing pipe must be provided. The Department of Transportation having jurisdiction of said road and right-of-way must grant specific approval.

1.2 REFERENCED STANDARDS

- A. All standard specifications, i.e., Federal, ANSI, ASTM, etc., made a portion of these Specifications by reference, shall be the latest edition and revision thereof.

1.3 QUALIFICATIONS

- A. Furnish all HDPE pipe, fittings, and appurtenances by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the items to be furnished.
- B. Installer Certification is required for the CONTRACTOR installing thermally butt-fused HDPE pipe.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, a list of materials to be furnished, the names of the suppliers, and the appropriate shop drawings for all HDPE pipe and fittings.
- B. Submit the pipe manufacturer's certification of compliance with the applicable sections of the Specifications.
- C. Submit shop drawings showing installation method and the proposed method and specialized equipment to be used.

1.5 INSPECTIONS AND TESTS

- A. All work shall be inspected by the County Manager or designee who shall have the authority to halt construction if, in his opinion, these specifications or standard construction practices are not being followed. Whenever any portion of these specifications is violated, the County Manager or designee, may order further construction to cease until all deficiencies are corrected.

1.6 WARRANTY AND ACCEPTANCE

- A. Warrant all work to be free from defects in workmanship and materials for a period of one year from the date of completion of all construction and final utility acceptance. If work meets these specifications, a letter of acceptance, subject to the one-year warranty period, shall be given. In the event deficiencies are discovered during the warranty period, the CONTRACTOR shall correct them without additional charge to the COUNTY, or the COUNTY may otherwise correct them by drawing upon the Utilities Performance Security. During the warranty period, the COUNTY will determine if warranty repairs or replacement work is needed. The decision of the COUNTY shall be binding upon the OWNER.

PART 2 PRODUCTS

2.1 POLYETHYLENE PIPE AND FITTINGS

- A. Provide polyethylene pressure pipe manufactured from PE4710 polyethylene meeting AWWA C906 standards. When specified by the ENGINEER on the construction drawings, as an alternate to PVC, HDPE (ductile iron pipe sized) piping can be used for buried applications. Iron pipe sized (IPS) HDPE piping can be used for below-ground applications as determined by the ENGINEER.
- B. The diameter of DR 11 HDPE casing pipe provided for roadway crossings or other purposes shall conform to the following.

For HDPE pressure carrier pipes, casing spacers are not required when HDPE DR11 (or DR17 for 42" to 54" or DR21 for 63") casing is used. The casing inside diameter shall be a minimum of two inches larger than the carrier pipe's outside diameter.
- C. HDPE to HDPE pipe connections shall be by thermal butt fusion. Thermal fusion shall be accomplished in accordance with the pipe manufacturer and fusion equipment supplier specifications. The CONTRACTOR installing thermal butt

fused HDPE pipe shall be certified in this type of work and have a minimum of five years experience performing this type of work. The CONTRACTOR shall provide certification to the Engineer of Record, who will provide the Engineering Review Services Department with the certification.

- D. Qualification of Manufacturer: The Manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications. The Manufacturer's production facilities shall be open for inspection by the County Manager or designee. Qualified manufacturers shall be approved by the County Manager or designee.
- E. See the County Approved Product List, Appendix F, for manufacturers that are qualified. Products from other manufacturers proposed for the work must receive approval from the County Manager or designee prior to ordering.
- F. Materials: Materials used for the manufacture of polyethylene pipe and fittings shall be PE4710 high density polyethylene meeting cell classification 445574C or 445574E per ASTM D3350; and meeting Type III, Class B or Class C, Category 5, Grade P34 per ASTM D1248; and shall be listed in the name of the pipe and fitting manufacturer in PPI (Plastics Pipe Institute) TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds, with a standard grade rating of 1600 psi at 73°F. The Manufacturer shall certify that the materials used to manufacture pipe and fittings meet these requirements.
- G. Polyethylene Pipe: Polyethylene pipe shall be manufactured in accordance with ASTM F714, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter or ASTM D3035, Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter and shall be so marked. Each production lot of pipe shall be tested for (from material or pipe) melt index, density, % carbon, (from pipe) dimensions and either quick burst or ring tensile strength (equipment permitting).
- H. Color Identification: HDPE must have at least three equally spaced horizontal colored marking stripes. Permanent identification of piping service shall be provided by adhering to the following colors.

Blue – potable water (Underground HDPE pipe shall be one of the following:

- a. Solid-wall blue pipe;
- b. Co-extruded blue external skin; or
- c. White or black pipe with blue stripes incorporated into, or applied to, the pipe wall.

White – raw water

Green – wastewater, sewage

Pantone Purple – non-potable irrigation, reclaimed or reuse water

- I. Polyethylene Fittings and Custom Fabrications: Polyethylene fittings and custom fabrications shall be molded or fabricated by the pipe manufacturer. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe. Pressure de-rated fabricated fittings are prohibited.
- J. Molded Fittings: Molded fittings shall be manufactured in accordance with ASTM D3261, Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing, and shall be so marked. Each production lot of molded fittings shall be subjected to the tests required under ASTM D3261.
- K. X-Ray Inspection: The Manufacturer shall submit samples from each molded fittings production lot to x-ray inspection for voids and shall certify that voids were not found.
- L. Fabricated Fittings: Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full service pressure rating of the mating pipe. Directional fittings 16" IPS and larger such as elbows, tees, crosses, etc., shall have a plain end inlet for butt fusion and flanged directional outlets. Part drawings shall be submitted for the approval of the ENGINEER.
- M. Polyethylene Flange Adapters: Flange adapters shall be made with sufficient through-bore length to be clamped in a butt fusion joining machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to provide gasketless sealing, or to restrain the gasket against blow-out.
- N. Back-up Rings and Flange Bolts: Flange adapters shall be fitted with lap joint flanges pressure rated equal to or greater than the mating pipe. The lap joint flange bore shall be chamfered or radiused to provide clearance to the flange adapter radius. Flange bolts and nuts shall be Grade 2 or higher.

2.2 MANUFACTURER'S QUALITY CONTROL

- A. The pipe and fitting manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier and verified by Manufacturer's Quality Control. Incoming materials shall be approved by Quality Control before processing into finished goods. Outgoing materials shall be checked for:

1. Outside diameter, wall thickness, and eccentricity as per ASTM D2122 at a frequency of at least once/hour or once/coil, whichever is less frequent.
 2. Out of Roundness at frequency of at least once/hour or once/coil, whichever is less frequent.
 3. Straightness, inside and outside surface finish, markings and end cuts shall be visually inspected as per ASTM F714 on every length of pipe.
- B. Quality Control shall verify production checks and test for:
1. Density as per ASTM D1505 at a frequency of at least once per extrusion lot.
 2. Melt Index as per ASTM D1238 at a frequency of at least once per extrusion lot.
 3. Carbon content as per ASTM D1603 at a frequency of at least once per day per extrusion line.
 4. Quick burst pressure (sizes thru 4-inch) as per ASTM D1599 at a frequency of at least once per day per line.
 5. Ring Tensile Strength (sizes above 4-inch equipment permitting) as per ASTM D2290 at a frequency of at least once per day per line.
 6. ESCR (size permitting) as per ASTM F1248 at a frequency of at least once per extrusion lot.
- C. X-ray inspection shall be used to inspect molded fittings for voids, and knit line strength shall be tested. All fabricated fittings shall be inspected for joint quality and alignment.

2.3 COMPLIANCE TESTS

- A. In case of conflict with Manufacturer's certifications, the CONTRACTOR, ENGINEER, or County Manager or designee may request re-testing by the manufacturer or have re-tests performed by an outside testing service. All re-testing shall be at the requestor's expense and shall be performed in accordance with the Specifications.
- B. Installation shall be in accordance with Manufacturer's recommendations and this specification. All necessary precautions shall be taken to ensure a safe working environment in accordance with the applicable codes and standards.

PART 3 EXECUTION

3.1 INSTALLATION OF HIGH-DENSITY POLYETHYLENE PRESSURE PIPE AND FITTINGS

- A. Install all high-density polyethylene (HDPE) pressure pipe by direct bury, directional bore, or a method approved by the COUNTY or ENGINEER prior to construction. If directional bore is used, or if directed by the County Manager or designee or ENGINEER, surround the entire area of construction by silt barriers.

Install all high-density polyethylene pressure pipe and fittings in accordance with Manufacturer's recommendations, and this specification. Take all necessary precautions to ensure a safe working environment in accordance with the applicable codes and standards.

3.2 HEAT FUSION JOINING

- A. Make joints between plain end pipes and fittings by butt fusion, and joints between the main and saddle branch fittings by using saddle fusion using only procedures that are recommended by the pipe and fitting Manufacturer. Ensure that persons making heat fusion joints have received training and certification for heat fusion in the Manufacturer's recommended procedure. Maintain records of trained personnel, and certify that training was received not more than 12 months before commencing construction. External and internal beads shall not be removed.

3.3 MECHANICAL JOINING

- A. HDPE pipe and fittings shall be fused together by heat welding when possible. HDPE pipe and fittings may be joined together or to other materials by means of flanged connections with back-up rings, by mechanical joint adapter with glands, or mechanical couplings designed for joining HDPE pipe or for joining HDPE pipe to another material. A stainless-steel sleeve insert shall be used with a mechanical coupling. Mechanical couplings shall be fully pressure rated and fully thrust restrained such that when installed in accordance with manufacturer's recommendations, a longitudinal load applied to the mechanical coupling will cause the pipe to yield before the mechanical coupling disjoins.

3.4 BRANCH CONNECTIONS

- A. Make branch connections to the main with saddle fittings or tees. Saddle fuse polyethylene saddle fittings to the main pipe.

3.5 EXCAVATION

- A. Excavate trenches in conformance to this specification, the plans and drawings, or as authorized in writing by the County Manager or designee, and in accordance

with all applicable codes. Remove excess groundwater. Where necessary, shore or reinforce trench walls.

3.6 LARGE DIAMETER FABRICATED FITTINGS

- A. Butt fuse fabricated directional fittings 16" IPS and larger to the end of a pipe. Make up the flanged directional outlet connections in the trench.

3.7 MECHANICAL JOINT AND FLANGE INSTALLATION

- A. Install mechanical joints and flange connections in accordance with the Manufacturer's recommended procedure. Center and align flange faces to each other before assembling and tightening bolts. Do not use the flange bolts to draw the flanges into alignment. Lubricate bolt threads, and fit flat washers under the flange nuts. Tighten bolts evenly according to the tightening pattern and torque step recommendations of the Manufacturer. At least one hour after initial assembly, re-tighten flange connections following the tightening pattern and torque step recommendations of the Manufacturer. The final tightening torque shall be 100 ft-lbs or less as recommended by the Manufacturer.

3.8 FOUNDATION AND BEDDING

- A. Lay pipe on grade and on a stable foundation. Remove unstable or mucky trench bottom soils, and install a 6-inch foundation or bedding of compacted Class I material to pipe bottom grade. Remove excess groundwater from the trench before laying the foundation or bedding and the pipe. A trench cut in rock or stony soil shall be excavated to 6 inches below pipe bottom grade and brought back to grade with compacted Class I bedding. Remove all ledge rock, boulders, and large stones.

3.9 PIPE HANDLING

- A. When lifting with slings, use only wide fabric choker slings to lift, move, or lower pipe and fittings. Do not use wire rope or chain. Slings shall be of sufficient capacity for the load and shall be inspected before use. Do not use worn or defective equipment.

3.10 TESTING

- A. Hydrostatic Pressure Testing: Pressure test and flush HDPE pipes after swabbing in accordance with Section 022501 and 025400.

END OF SECTION

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SECTION 330503

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for providing buried PVC pipe, fittings and appurtenances.
 - 1. Provide PVC pipe and fittings complete with all necessary jointing facilities and materials, specials, adapters and other appurtenances required for installation in and completion of the pipelines to be constructed.
 - 2. Provide plain end or rubber gaskets (push-on or mechanical joint) of the types, sizes and classes shown or specified.
- B. Related Work Specified In Other Sections Includes:
 - 1. Section 022501 – Leakage Tests
 - 2. Section 025400 – Disinfection
 - 3. Section 330504 – Ductile Iron Pipe and Fittings
 - 4. Section 330518 – Laying and Jointing Buried Pipelines

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. ASTM D3034 - Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
 - 2. ASTM F679 - Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
 - 3. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 60 In., for Water Distribution
 - 4. AWWA C907 - Polyvinyl Chloride (PVC) Pressure Fittings for Water - 4 In. through 8 In.

5. ASTM D2321 - Underground Installation of Flexible Thermoplastic Sewer Pipe
6. ASTM F477 - Elastomeric Seals (Gaskets) For Joining Plastic Pipe
7. ANSI A21.10 - Ductile-Iron and Gray-Iron Fittings 3 inches through 48 inches, for Water and Other Liquids
8. ANSI A21.11 - Rubber-Gasket Joints for Ductile-Iron and Gray Iron Pressure Pipe and Fittings
9. Uni-Bell B-11

1.3 SYSTEM DESCRIPTION

- A. Gravity Sewer Pipe - PVC pipe shall be of the integral wall bell and spigot joint type, which meets or exceeds all requirements set forth in ASTM D3034, latest revision. Minimum wall thickness shall conform to ASTM SDR 26. PVC pipes used for gravity sewers shall be green in color. Fittings shall be made of PVC plastic as defined by ASTM SDR 26 1784, latest revision. Flexible gasketed joints shall be compression type conforming to ASTM D3201, latest revision. Elastomeric joint gaskets shall conform to ASTM F477, latest revision. At all conflict crossings using 4"-12" substitute C900 PVC, Class 305, DR 14 and for PVC pipe 14" and larger use C900 PVC, Class 235, DR 18.
- B. Force Main Pipe – PVC pipe meeting the latest revision of AWWA C900 shall be provided. For installation of 4" – 12" pipe, the pressure class shall be 235 with a DR of 18. For installation of 14" – 24" pipe, use pressure class 165, DR 25, meeting or exceeding the requirements of Uni-Bell B-11. PVC pipes used for force mains shall be green in color. Outside diameters shall be equivalent to ductile iron pipe of the same nominal size. Joints between successive lengths of straight PVC pipe shall be compression type using a single elastomeric gasket, per ASTM C-3139 and F477. Fittings for C900 pipe shall be C900 rated PVC. Joint restraint devices shall be provided for horizontal or vertical alignment changes using uni-flange type collars, epoxy coated, with high strength, and low alloy hardware (see County Approved Product List, Appendix F). PVC pipe direct buried beneath roadways, parking lots or parking lot entrances shall meet AWWA Specification C900, latest revision. All 4" to 12" pipe in such locations shall be a minimum of Class 305, DR 14, and all 14" to 24" pipe shall be a minimum of Class 235, DR 18. Pressure Class 250 ductile iron pipe may be used instead of PVC in these locations if approved by the County Manager or designee.
- C. Potable, Raw and Non-Potable Irrigation Water Main Pipe - PVC shall conform to AWWA Specification C900, latest revision. All 4" to 12" pipe shall be a minimum of Class 235, DR 18 and all 14" to 24" pipe shall be a minimum of Class 165, DR 25 and shall meet or exceed Uni-Bell B-11. All potable water pipe shall bear the seal of the National Sanitation Foundation (NSF) for potable water pipe. All pipe shall be marked with the manufacturer's name, nominal size, type of plastic and pressure rating. All PVC pipe used for potable water lines shall be predominately

blue in color. Underground PVC pipes used for potable water lines shall be solid-wall blue pipe, will have a co-extruded blue external skin, or will be white or black pipe with blue stripes incorporated into, or applied to, the pipe wall. PVC pipes used for raw water shall be white in color. PVC pipes used for non-potable irrigation, reclaimed or reuse water shall be purple in color. Pipe O.D. shall be equivalent to cast iron pipe of the same nominal size. PVC pipe direct buried beneath roadways, parking lots or parking lot entrances shall meet AWWA Specification C900, latest revision. All 4" to 12" pipe in such locations shall be a minimum of Class 305, DR 14, and all 14" to 24" pipe shall be a minimum of Class 235, DR 18. Pressure Class 250 ductile iron pipe may be used instead of PVC in these locations if approved by the County Manager or designee.

- D. Provide pipe of the various sizes and classes as specified in the schedule or shown. Restrain all pressure pipe joints.
- E. Construct concrete encasements only with written permission from the Water Director.

1.4 SUBMITTALS

- A. General: Provide all submittals, including the following, as specified in Division 1.
- B. Submit the following shop drawings:
 - 1. Pipe joints, fittings, sleeves and cleanouts. Where special designs or fittings are required, show the work in large detail and completely describe and dimension all items.
 - 2. Fully dimensioned drawings of piping layouts, including fittings, couplings, sleeves, cleanouts, valves, supports and anchors. Label pipe size, materials, type, and class on drawings and include the limits of each reach of restrained joints. Provide cross sections showing elevations of cleanouts, pipes, fittings, sleeves, and valves.
 - 3. Catalog data for pipe, joints, fittings, sleeves, harnessing and cleanouts.
- C. Quality Control: Submit certificate of compliance for pipe, fittings, gaskets, coatings, specials, sleeves and cleanouts in accordance with this Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle all pipe, fittings and appurtenances as specified in Division 1 and Section 330518.

PART 2 PRODUCTS

2.1 MATERIALS

- A. PVC Pipes and Fabricated Fittings: PVC pipe and fabricated fittings shall be made from virgin PVC resin that has been compounded to provide physical and chemical properties that equal or exceed cell class 12454-B as defined in ASTM D1784, and shall qualify for a hydrostatic design basis of 4,000 psi (27.58 MPa) at 73.4°F (23°C) per the requirements of PPI TR-3.
- B. Fittings for Pressure Pipe: Provide all fittings meeting the requirements of Sections 330504.
- C. Joints and Fittings for Gravity Sewer Pipe: Provide all fittings meeting the requirements of ASTM D 3034 and ASTM F 679. Provide joints that are a molded integral part of the pipe section. Do not use joints or couplings furnished loose. Provide joints with elastomeric gasket joints.
- D. Joints for Pressure Pipe: Provide pipe with bell ends in accordance with AWWA C900. Provide joints with elastomeric gasket joints.
- E. Elastomeric Gasket Joints: Provide elastomeric gasket joints in accordance with ASTM F 477.
- F. Rubber Gasket Joints: Provide mechanical joints meeting the requirements of ANSI A21.11.
- G. Color: Provide pipe made of 100 percent of the color specified. Provide green sewer or force main pipe. Provide blue potable water pipe. Provide white raw water pipe. Provide purple non-potable irrigation, reclaimed or reuse water pipe.
- H. Pipe Marking: Provide mark on each pipe at internals of 5 feet or less to designate compliance with applicable ASTM or AWWA specification.
- I. Temporary Bulkheads: Provide temporary bulkheads at the ends of sections where adjoining pipelines have not been completed and are not ready to connect.
 - 1. Remove all temporary bulkheads when they are no longer needed.
- J. Date of Manufacturer: Provide pipe and fitting manufactured no earlier than 12 month period proceeding the date of the Agreement.
- K. Wall Thickness for Pressure Pipe:
 - 1. 4 through 12 inches diameter – provide AWWA-C900 DR 14, Class 305 for pressure pipe installed under pavement.

2. 14 through 24 inches diameter – provide AWWA-C905 DR 18, Class 235 for pressure pipe installed under pavement.
- L. Restraining Devices: Joint restraining devices (see County Approved Product List, Appendix F) shall be placed at all bends, tees, plugs, reducers, and other fittings to provide lateral support, and shall conform to the Collier County Standard Details. Concrete thrust blocks shall only be utilized if approved by Collier County Utilities.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install all buried PVC pipe and fittings in accordance with the manufacturer's recommendations, approved shop drawings, as specified in Division 1, and Section 330518. For horizontal directional drilling of Fusible PVC, see Section 330502 for casing and execution requirements.

3.2 LEAKAGE TESTING

- A. Cleaning: Flush clean and test all pipes after installation.
- B. Testing: Test pipes for leaks and repair or tighten as required.
- C. Procedures: Conduct tests in accordance with Section 022501.

3.3 DISINFECTION

- A. General: Disinfect all pipelines that are to carry potable water before they are placed in service as specified in Section 025400.

3.4 SCHEDULES

- A. Refer to the Schedules contained in Section 330518 Laying and Jointing Buried Pipelines for information on the piping that is to be constructed using the pipe materials and methods specified herein.

END OF SECTION

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SECTION 330504

DUCTILE IRON PIPE (DIP) AND FITTINGS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required, and install ductile iron pipe, fittings and appurtenances as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 330518 - Laying and Jointing Buried Pipe

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards: (Latest Revision)

1. ANSI/AWWA C104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
3. ANSI/AWWA C110/A21.10 Ductile-Iron Fittings, 3 in. Through 48 Inches, for Water and Other Liquids. (C110 2-48 inches).
4. ANSI/AWWA C111/A21.11 Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. ANSI/AWWA C115/A21.15 Flanged Ductile-Iron Pipe with Threaded Flanges.
6. ANSI/AWWA C150/A21.50 Thickness Design of Ductile-Iron Pipe.
7. ANSI/AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast for Water or Other Liquids.
8. ANSI/AWWA C153/A21.53 Ductile-Iron Compact Fittings
9. AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances.
10. Collier County Utilities Standards and Procedures Ordinance

1.4 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Submit shop drawings of pipe and fittings in accordance with the requirements in the General Conditions, the requirements of the referenced standards and the following supplemental requirements as applicable:
 - 1. Certified dimensional drawings of all valves, fittings, and appurtenances.
 - 2. In all cases, a line layout to indicate the limits of each reach of restrained joints or of concrete encasement shall be supplied. (NOTE: Obtain COUNTY Water Director's approval of all proposed concrete encasement of ductile iron pipe.)
- B. Certifications: Furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, which indicates that all tests have been made and that all results comply with the requirements of AWWA C151, including but not necessarily limited to the following:
 - 1. Acceptance Tests.
 - 2. Hydrostatic Tests.
 - 3. Impact Tests.
- C. Additional Documentation: Upon request, furnish foundry records in the form of written transcripts.
- D. All expenses incurred for certification, testing, and data submittal shall be borne by the CONTRACTOR or the Supplier.

1.5 QUALITY ASSURANCE

- A. Inspection: All pipe shall be available for inspection at the place of manufacture prior to shipping in accordance with the provisions of the referenced standards. Notify the ENGINEER in writing not less than 10 calendar days prior to the shipping of the pipe.
- B. The ENGINEER shall be given access to all areas where manufacturing and testing is performed and shall be permitted to make all inspections necessary to confirm manufacturer compliance with these Specifications.
- C. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- D. Provide data on material tests at no additional cost to the COUNTY.

- E. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including lining and coating samples for testing by the COUNTY. Furnish the additional samples at no additional cost to the COUNTY.

1.6 CORROSION PROTECTION

- A. If specifically approved by Collier County Utilities for use, provide exterior protection for underground ductile iron pipe and fittings within areas of severe corrosive conditions. This shall be accomplished by the installation of polyethylene encasement through the area of concern. The soil test evaluation to determine the necessity for extra protection in suspect areas shall be those set forth in ANSI Standard A21.5. Additionally, where other existing utilities are known to be cathodically protected, ductile iron pipe crossing said utility shall be protected for a distance of 20 feet to each side. If ductile iron pipe is to be installed parallel to and within 10 feet of cathodically protected pipe, then protection shall be provided for the entire length. Do not install steel pipe in severe corrosion areas.

PART 2 PRODUCTS

2.1 GENERAL

- A. Protective Lining for Water Mains: Cement mortar lined ductile iron pipe shall conform to ANSI/AWWA C151 and C104, subject to the following supplemental requirements. The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all specials and fittings shall be provided as required under the Contract Documents.
- B. Protective Lining for Force Mains and Sewers: Where lining is shown, specified or required, for the protection of pipelines carrying sewage from corrosive gases, line the pipe using protective ceramic epoxy coating (see County Approved Product List, Appendix F) in accordance with the manufacturer's written instructions. For ceramic epoxy lining, abrasive blast clean pipe and fittings to a near white surface to SSPC SP-10 and provide 40 mils minimum of dry film thickness of ceramic epoxy lining.
- C. Handling and Storage: Handle the pipe by using wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe and its lining. The use of equipment or handling, which might injure the pipe and its lining, will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling. Assure that all other pipe handling equipment and methods is acceptable to the ENGINEER.
- D. Laying lengths: Maximum pipe laying lengths shall be 20 feet.

- E. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness, in accordance with ANSI/AWWA C104.
- F. Closures and Correction Pieces: Provide closures and correction pieces as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings or line layouts where applicable.

2.2 PIPE DESIGN CRITERIA

- A. General: Ductile Iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150 as applicable and as modified in this Section.
- B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design internal pressure in accordance with the hoop stress formula. In addition to the requirements of the Section, the minimum wall thickness shall be in accordance with the minimum thickness wall depicted in table 50.5 of ANSI/AWWA C150.
- C. Potable, Raw and Non-Potable Irrigation Water Mains:
 - 1. Ductile Iron Pipe shall be a minimum pressure Class 250 and will be accepted in any diameter for use within the water distribution system.
 - 2. All aboveground potable water main pipe shall be painted Federal Safety Blue. All aboveground raw water main pipe shall be painted white. All aboveground non-potable irrigation, reclaimed or reuse water main pipe shall be painted Pantone Purple 522C. The pipe wall thickness shall not be less than that required by a working pressure of 250 psi in laying condition Type 4 "B" with 5-foot cover in conformance with ANSI Standard A21.50.
- D. Force Mains and Gravity Sewers:
 - 1. Ductile Iron Pipe shall be a minimum pressure Class 150 and will be accepted in any diameter for use within the wastewater collection system.
 - 2. Ductile iron pipe for Gravity Sewer applications is not permitted unless the ENGINEER can demonstrate that C900 PVC pipe, Class 150 or 200, cannot be utilized from a structural standpoint.
 - 3. All aboveground force main pipe shall be painted Safety Green. The pipe wall thickness shall not be less than that required by a working pressure of 150 psi.

2.3 MATERIALS

- A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.
- B. Adapters to connect ductile iron pipe or fittings to pipe or fittings of dissimilar materials shall be supplied by the CONTRACTOR in accordance with ASTM specifications and the pipe manufacturer recommendations, and as approved by the ENGINEER.
- C. Water Mains:
 - 1. All water mains shall contain cement for mortar lining conforming to the requirements of ANSI/AWWA C104. Cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used.
 - 2. All Ductile Iron buried water main pipelines shall have blue stripes applied to the pipe wall. Stripe width shall comply with AWWA standards. The stripes shall be applied during installation and shall incorporate blue tape or blue paint. The tape or paint shall be applied in a continuous line that runs parallel to the axis of the pipe and be located along the top of the pipe.
 - 3. All pipe with an internal diameter of 24" or greater, tape or paint shall be applied in continuous lines along each side of the pipe as well as along the top of the pipe.
- D. Force Mains and Gravity Sewer:
 - 1. All Ductile iron pipe used within the wastewater system shall be lined with a ceramic epoxy, (see County Approved Product List, Appendix F). Pipe and fittings shall be lined as specified herein. Each piece of pipe shall bear a marking denoting the class to which it belongs.

2.4 SPECIALS AND FITTINGS

- A. Fittings for Potable, Raw, Non-Potable Irrigation, Reclaimed and Reuse Water Systems:
 - 1. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3 inches through 48 inches and shall have a minimum pressure rating of 350 psi for pipe sizes 6 inches through 24 inches and 250 psi for sizes larger than 24 inches. Ductile iron fittings shall be double cement lined, seal coated and outside coated with an asphaltic material in accordance with AWWA C104 as specified.
- B. Fittings for Wastewater System:

1. All pipe and fittings in direct contact with wastewater shall be interior coated with a 40 mil thickness of ceramic epoxy coating (see County Approved Product List, Appendix F). Pipe and fittings shall have an outside asphaltic coating as specified in AWWA Standard C151. Each piece of pipe shall bear a marking denoting the class to which it belongs.

2.5 DESIGN OF PIPE

- A. General: The pipe furnished shall be ductile iron pipe, lined as specified, with rubber gasketed joints.
- B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C150 and ANSI/AWWA C151.
- C. Pipe Dimensions: The pipe shall be of the diameter and class shown. The minimum wall thickness for each pipe size shall be as specified herein or shown on the Drawings.
- D. Fitting Dimensions: The fittings shall be of the diameter shown and class specified.
- E. Joint Design: Ductile Iron pipe and fittings shall be furnished with mechanical joints, push-on joints and flanged joints as follows:
 1. For buried pipe applications, unless otherwise indicated, mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11, with the minimum pressure rating of 350 psi.
 2. For above-ground or buried vault applications, unless otherwise indicated, flanged joints shall conform to ANSI/AWWA C115/A21.15, with the minimum pressure rating of 250 psi. All above-ground fittings shall be painted blue.
 3. Use manufactured, labeled gasket lubricant for push on joints with trade name and pipe manufacturer name, other lubricants are prohibited.
 4. Nuts and bolts for flanged joints shall be 304 stainless, as specified by the COUNTY, and conform to ANSI/AWWA C111.
- F. Restraining Devices: Joint restraining devices (see County Approved Product List, Appendix F) shall be placed at all bends, tees, plugs, reducers, and other fittings to provide lateral support, and shall conform to the Collier County Standard Details. Concrete thrust blocks shall only be utilized if approved by Collier County Utilities.
- G. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself will provide watertight joints under all operating conditions

when properly installed. Require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

- H. Gaskets shall be a Buna N, Neoprene, or a Nitril-based rubber product. Gaskets shall have clean tips unless otherwise specified. Elastomeric gaskets conforming to ASTM F-477 shall also be acceptable.
- I. Shop-applied interior linings and exterior coatings shall be applied evenly to the nominal thickness specified. Exterior coatings: asphalt coating for buried pipe or primed pipe cannot be furnished holiday free.

2.6 CEMENT-MORTAR LINING

- A. Cement-Mortar Lining For Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. Ductile-Iron pipefittings need not have the cement-mortar lining applied centrifugally. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be repaired in the field in accordance with ANSI/AWWA C104.
- B. The nominal wet lining thickness shall be as follows:

Nominal Factory Nominal Replacement		
Nominal Pipe Diameter (in.)	Applied Lining Thickness (in.)	Lining Thickness (in.)
3-12	1/8	1/8
14-24	3/16	3/16
30-64	1/4	1/4

- C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.7 EXTERIOR COATING OF PIPE

- A. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately 1 mil thick, conforming to ANSI/AWWA C151.

2.8 CORROSION PROTECTION

- A. If specifically approved by Collier County Utilities for use, exterior protection shall be provided for underground ductile iron pipe and fittings within areas of severe

corrosive conditions. This shall be accomplished by the installation of polyethylene encasement through the area of concern. The soil test evaluation to determine the necessity for extra protection in suspect areas shall be those set forth in ANSI Standard A21.5. Additionally, where other existing utilities are known to be cathodically protected, ductile iron pipe crossing said utility shall be protected for a distance of 20 feet to each side. If ductile iron pipe is to be installed parallel to and within 10 feet of cathodically protected pipe, then protection shall be provided for the entire length. Steel pipe shall not be installed in severe corrosion areas.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE

- A. Handling and Storage: Carefully handle and protect all pipe, fittings, etc., against damage, impact shocks, and free fall and in accordance with ANSI/AWWA C600. Do not place pipe directly on rough rocky ground, but in such instances support the pipe in a manner that will protect the pipe against injury whenever stored at such trench site or elsewhere. Do not install any pipe where the lining or coating show defects that may be harmful as determined by the ENGINEER. Repair such damaged lining or coating, or furnish and install a new undamaged pipe.
- B. Repair or replace all pipe damaged prior to Substantial Completion or during warrantee period.
- C. Inspect each pipe and fitting prior to installation to insure that no damaged portions of pipe are installed.
- D. Before placement of pipe in the trench, thoroughly clean each pipe or fitting of any foreign substance that may have collected therein, and keep the pipe clean at all times thereafter. For this purpose, close the openings of all pipes and fittings in the trench during any interruption to the work.
- E. Pipe Laying: Install the pipe in accordance with ANSI/AWWA C600.
- F. Lay pipe directly on the bedding material. Refer to the Utilities Standards and Procedures Ordinance Section 9.1.2 for laying and backfilling requirements. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Make excavations as needed to facilitate removal of handling devices after the pipe is laid. Form bell holes at the ends of the pipe to prevent point loading at the bells or couplings. Make excavations as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grades. Such

change may be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 70 percent of the maximum deflection recommended by the pipe manufacturer. No joint shall be misaligned any amount which will be detrimental to the strength and water tightness of the finished joint.

- H. Pipe and Specials Protection: Protect the openings of all pipe and specials with suitable bulkheads to prevent unauthorized access by persons, animals, water, or any undesirable substance. At all times, provide means to prevent the pipe from floating.
- I. Pipe Cleanup: As pipe laying progresses, keep the pipe interior free of all debris. Completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints, and any necessary interior repairs per ANSI/AWWA C600 and C602 prior to testing and disinfecting the completed pipeline. For pipe larger than 12" diameter, utilize a polyurethane foam plug "Poly Pig" to remove all debris from main.

3.2 RUBBER GASKETED JOINTS

- A. Rubber Gasketed Joints: Immediately before jointing pipe, thoroughly clean the bell end of the pipe, and place a clean rubber gasket in the bell groove. Carefully clean the bell and spigot end of push-on joint pipe, and lubricate with a vegetable-based lubricant or per manufacturer's recommendation. Insert the spigot end of the pipe section into the bell of the previously laid joint and telescope into the proper position. Do not tilt the pipe to insert the spigot into the bell.

3.3 INSTALLATION OF PIPE APPURTENANCES

- A. Installation of Valves: Handle all valves in a manner to prevent any injury or damage to any part of the valve. Thoroughly clean and prepare all joints prior to installation. Adjust all stem packing and operate each valve prior to installation to insure proper operation.
- B. Install all valves so that the valve stems are plumb and in the location shown on the Drawings.
- C. Mechanical joints consisting of bell, socket, gland, gasket, bolts, and nuts shall conform to ANSI Standard A21.11. Bolts and nuts shall be high strength, low alloy, Cor-Ten, T-Head Type having hexagonal nuts. Bolts and nuts shall be machined through and nuts shall be tapped at right angles to a smooth bearing surface. Single sealed gasket push-on type joints (see County Approved Product List, Appendix F) shall conform to the requirements of ANSI A21.11.
- D. Mechanical joint retainer glands may be used to restrain mechanical joint pipe and fittings to the plain end of ductile iron pipe and fittings when used in conjunction with thrust blocks of reduced size. The Utilities ENGINEER must approve thrust block size. Maintain joint flexibility.

3.4 TESTING AND DISINFECTION

- A. Test completed water or force main pipeline in accordance with Section 022501.
Disinfect completed water pipeline in accordance with Section 025400.

END OF SECTION

SECTION 330518

LAYING AND JOINTING BURIED PIPELINES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Installation of all underground pipelines. Provide pipeline materials, coatings and linings as specified and pipe of the types, sizes and classes shown or specified.
 - 1. Use proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fittings.
 - 2. Use suitable fittings where shown and at connections or where grade or alignment changes require offsets greater than those recommended and approved.
 - 3. Lay all underground pipelines not supported on piles or concrete cradle in select fill bedding material.
 - 4. Close off all lines with bulkheads when pipe laying is not in progress.
- B. Related Work Specified in Other Sections Includes:
 - 1. Section 022501 – Leakage Tests
 - 2. Section 025400 – Disinfection
 - 3. Section 312316 – Excavation - Earth and Rock
 - 4. Section 312319 – Groundwater Control for Open Excavation
 - 5. Section 312323 – Backfilling
 - 6. Section 330502 – High Density Polyethylene (HDPE) Pipe and Fittings
 - 7. Section 330503 - Polyvinyl Chloride (PVC) Pipe and Fittings
 - 8. Section 330504 - Ductile Iron Pipe (DIP) and Fittings

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:

1.	ASTM D 2774	- Practice for Underground Installation of Thermoplastic Pressure Piping
2.	AWWA C600	- Installation of Ductile-Iron Water Mains and Their Appurtenances
3.	ASTM A 307	- Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile
4.	ASME B16.1	- Cast Iron Pipe Flanges and Flanged Fittings, C25, 125, 250, 800
5.	ASME B16.21	- Nonmetallic Flat Gaskets for Pipe Flanges
6.	AWWA C111/A21.11	- Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
7.	AWWA C115/A21.15	- Flanged Ductile-Iron Pipe With Threaded Flanges
8.	Uni-Bell	- Handbook of PVC Pipe
9.	Collier County	- Utilities Standards and Procedures Ordinance

1.3 DELIVERY, STORAGE AND HANDLING

- A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows:
- B. Transportation and Delivery: Take every precaution to prevent injury to the pipe during transportation and delivery to the site.
- C. Loading and Unloading: Take extreme care in loading and unloading the pipe and fittings.
 - 1. Work slowly with skids or suitable power equipment, and keep pipe under perfect control at all times.
 - 2. Under no condition is the pipe to be dropped, bumped, dragged, pushed, or moved in any way that will cause damage to the pipe or coating.
- D. Sling: When handling the pipe with a crane, use a suitable sling around the pipe.
 - 1. Under no condition pass the sling through the pipe. Interior of pipe is to be kept free of dirt and foreign matter at all times.
 - 2. Use a nylon canvas type sling or other material designed to prevent damage to the pipe and coating.

3. When handling reinforced concrete pipe or uncoated steel or ductile iron pipe, steel cables, chain or like slings are acceptable.
- E. Damaged Piping: If in the process of transportation, handling, or laying, any pipe or fitting is damaged, replace or repair such pipe or pipes.
- F. Blocking and Stakes: Provide suitable blocking and stakes installed to prevent pipe from rolling.
 1. Obtain approval for the type of blocking and stakes, and the method of installation.
- G. Storage for Gaskets: Store gaskets for pipe joints in a cool place and protect gaskets from light, sunlight, heat, oil, or grease until installed. Store gaskets in a sealed container (such as a vented drum). When long-term storage with exposure to direct sunlight is unavoidable, PVC pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excessive heat accumulation (Uni-Bell PVC Handbook).
 1. Do not use any gaskets showing signs of cracking, weathering or other deterioration.
 2. Do not use gasket material stored in excess of six months without approval.

1.4 FIELD CONDITIONS

- A. Repair of Sanitary Sewers and Services: Rebed, in compacted select fill material, sanitary sewers which cross over the new pipe or which cross under the new pipe with less than 12 inches clear vertical separation. Compact the bedding to densities required for new pipeline construction and extend bedding below the sewer to undisturbed earth. Reconstruct sewers damaged by pipeline construction.
 1. Furnish and install all materials and do all work necessary for the reconstruction or repairs of sanitary sewers and services.
 2. Provide pipe for reconstruction of sanitary sewers and services meeting the appropriate specification requirements.
 3. Provide pipe of the same size as the existing sewer or when the same size is not available, use the next larger size of pipe. Obtain approval of joints made between new pipe and existing pipe.

PART 2 PRODUCTS

- A. The materials allowed for buried sewer pipes are PVC, HDPE or Ductile Iron Pipe.

PART 3 EXECUTION

3.1 PREPARATION

- A. Dry Trench Bottoms: Lay pipe only in dry trenches having a stable bottom.
 - 1. Where groundwater is encountered, make every effort to obtain a dry trench bottom in accordance with Section 312319.
 - 2. Perform trench excavation and backfill in accordance with Sections 312316 and 312323.

3.2 INSTALLATION

- A. General: Install all piping in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1. Where pipe joint deflections are used, do not exceed 80 percent of the maximum deflection limits shown in AWWA C600. Gravity systems shall contain no joint deflection.
 - 1. Arrange miscellaneous pipelines, which are shown in diagram form on the Plans, clear of other pipelines and equipment.
 - 2. Gravity systems shall not contain vertical dips greater than one inch (1.0").
- B. Code Requirements: Provide pipeline installations complying with AWWA C600 for iron pipe, AWWA Manual M11 for steel pipe, ASTM D 2774 for thermoplastic pressure piping, and as modified or supplemented by the Specifications.
- C. Pipe Laying - General:
 - 1. Thoroughly inspect all pipe for damage and cleanliness. If found to be defective, tag, remove and replace pipe with satisfactory pipe or fittings at no additional charge to COUNTY.
 - 2. Generally, lay all pipe with bells pointing ahead.
 - 3. Carefully place all pipe, pipe fittings, valves and hydrants into trench by means of a derrick, ropes or other suitable tools or equipment in such a manner as to prevent damage and check for alignment and grade.
 - 4. Make adjustments to bring pipe to line and grade by scraping away or filling in select fill material under the body of the pipe.
 - 5. Wedging or blocking up the pipe barrel is not permitted.

6. Bring the faces of the spigot ends and the bells of pipes into fair contact and firmly and completely shove the pipe home.
7. As the work progresses, clean the interior of pipelines of all dirt and superfluous materials of every description.
8. Keep all lines absolutely clean during construction.
9. Lay pipelines accurately to line and grade.
10. During suspension of work for any reason at any time, a suitable stopper shall be placed in the end of the pipe last laid to prevent mud or other material from entering the pipe.

D. Pipe Laying - Trenches:

1. Carefully lay all pipelines in trench excavations piece by piece using suitable tools or equipment on select fill bedding (refer to Utilities Standards and Procedures Ordinance, Section 9.1.2), concrete cradle or other foundations as shown, specified or ordered in writing. Prevent damage to materials, protective coatings and linings.
2. Do not dump or drop pipe or pipe materials into trench.
3. Properly secure the pipe against movement and make the pipe joints in the excavation as required.
4. Carefully grade and compact pipe bedding.
5. Bell Holes:
 - a. Cut out bell holes for each joint as required to permit the joint to be properly made and allow the barrel of the pipe to have full bearing throughout its length.
 - b. Thoroughly tamp bell holes full of select fill material following the making of each joint to provide adequate support to the pipe throughout its entire length.

E. Other Foundations: Install pipelines laid on other types of foundations as specified for such other foundations or as ordered in writing.

F. Field Cuts of Pipelines: For shorter than standard pipe lengths, make field cuts in a manner producing a cut square and perpendicular to the pipe axis. Remove any sharp, rough edges which otherwise might injure the gasket.

G. Procedure for sealing cut ends and repairing field damaged areas of polyethylene lined pipe and fittings is as follows:

1. Remove burrs caused by field cutting of ends or handling damage and smooth out edge of polyethylene lining if made rough by field cutting or handling damage.
2. Remove oil or lubricant used during field cutting operations.
3. Areas of loose lining associated with field cutting operation must be removed and exposed metal cleaned by sanding or scraping. For larger areas, remove loose lining and dirt, then roughen bare pipe surface by scratching or gouging with a small chisel to provide an anchor pattern for the epoxy. It is recommended that the polyethylene lining be stripped back by chiseling, cutting, or scraping about 1 inch to 2 inches into well adhered lined area before patching. This ensures that all areas of undercutting have been removed. Be sure to roughen an overlap of 1 inch to 2 inches of polyethylene lining in area to be epoxy coated. This roughening should be done with a rough grade emery paper (40 grit), rasp, or small chisel. Avoid honing, buffing, or wire brushing since these tend to make surface to be repaired too smooth for good adhesion.
4. With area to be sealed or repaired clean and suitably roughened, apply a thick coat of a two-part coal tar epoxy (see County Approved Product List, Appendix F). The heavy coat of epoxy must be worked into the scratched surface by brushing. Mixing and application procedure for the epoxy must follow the epoxy manufacturer's instructions.
5. It is important that the entire freshly cut, exposed metal surface of the cut pipe be coated. To ensure proper sealing, overlap at least 1 inch of the roughened polyethylene lining with this two-part epoxy system.

H. Ductile Iron Pipe Mechanical Joints:

1. Assembly: In making up mechanical joints, center the spigot in the bell.
 - a. With a wire brush just prior to assembly of the joint thoroughly brush 8 inches outside of spigot and inside of bell with which the rubber gasket comes in contact. Remove all oil, grit, tar (other than standard coating) and other foreign matter from joint.
 - b. Brush lubricant over the gasket just prior to installation. (Note: There is only one rubber gasket size for each diameter of pipe.)
 - c. Press the gasket into place within the bell and move the gland into position, bolts inserted, and the nuts tightened finger tight.
 - d. Tighten the nuts with a torque wrench so that the gland is brought up toward the pipe evenly. Torque wrenches shall be set as specified in AWWA C111. Spanner type wrenches not longer than specified in

AWWA C111 may be used with the permission of County Manager or designee.

- e. Tighten all nuts 180 degrees apart alternately in order to produce equal pressure on all parts of the gland.

2. Torques: Apply the following range of bolt torques:

<u>Size Inches</u>	<u>Range of Torque - ft. lbs</u>
5/8	40 - 60
3/4	60 - 90
1	70 - 100
1-1/4	90 - 120

3. Remaking of Joints: If effective sealing is not obtained at the maximum torque listed above, disassemble and reassemble the joint after thorough cleaning.

I. Ductile Iron Pipe Rubber Gasket Joints:

1. Assembly: In making up the rubber gasket joint, brush the gasket seat in the socket thoroughly with a wire brush and wipe the gasket with a cloth.
 - a. Place the gasket in the socket with the large round end entering first so that the groove fits over the bead in the seat.
 - b. Apply a thin film of lubricant (AWWA C600) to the inside surface of the gasket that will come in contact with the entering pipe.
 - c. Brush the plain end of the pipe to be entered thoroughly with a wire brush and place it in alignment with the bell of the pipe to which it is to be joined.
 - d. Exert sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket to make the joint.
2. Positioning: Before proceeding with backfilling, feel completely around the joint using a feeler gauge to confirm that the gasket is in its proper position.
 - a. If the gasket can be felt out of position, withdraw the pipe and examine the gasket for cuts or breaks.
 - b. If the gasket has been damaged, replace it with a new one before re-installing the pipe.

3. Optional Mechanical Joints: Use mechanical joint fittings that meet the requirements of Section 330504 with the rubber gasket joint pipe when specified or when rubber gasket fittings are not available.
- J. Temporary Bulkheads: Provide temporary bulkheads at the ends of sections where adjoining pipelines have not been completed, and in connections built into pipelines where adjoining pipelines or structures have not been completed and are not ready to be connected.
1. Remove bulkheads encountered in connecting sewers or structures included in this Contract, or in pipelines or structures previously built, when they are no longer needed or when ordered.
- K. Temporary Blow-Off Assembly: Dead-end water lines shall be temporarily ended with a blow-off as shown in Collier County Standard Details. After full bore flush replace with a fire hydrant meeting the requirements of Section 331619.
- L. Sleeve Type Couplings: For sleeve type couplings, equally tighten diametrically opposite bolts on the connection so that the gaskets will be brought up evenly all around the pipe.
1. Torque Wrenches: Do the final tightening with torque wrenches set for the torque recommended by the coupling manufacturer.
- M. Concrete Encasement: Concrete encasement shall be constructed in accordance with Collier County Standard Details when:
1. A potable water main crosses at a depth that provides less than 18 inches clear distance from sewer lines in which case a Deviation Form request should be completed. Encase the sewer main unless specifically approved by Collier County Utilities. Encasement shall extend a minimum 10 feet on each side of the point of crossing. Pressure test both pipelines to 150 psi after the concrete has properly cured.
 2. A water main running parallel to a sewer line provides less than 10 feet separation from sewer lines, in which case a Deviation Form Request needs to be completed. Encase the sewer main unless specifically approved by Collier County Utilities.
 3. The ENGINEER has ordered the line encased. NO POTABLE WATER MAIN SHALL BE ENCASED IN CONCRETE UNLESS SPECIFICALLY AUTHORIZED BY THE COUNTY MANAGER OR DESIGNEE.

The points of beginning and ending of pipe encasement shall be not more than 6 inches from a pipe joint to protect the pipe from cracking due to uneven settlement of its foundation or the effects of superimposed live loads.

N. Valve Box Setting: Install valve boxes vertical and concentric with the valve stem.

1. Adjust valve-box to final grade at the time designated by the County Manager or designee.
2. Build a collar, as shown in the standard details, 18 inches by 18 inches by 6 inches or 24 inch diameter round by 6 inches flush to grade of top of box. Similar collar shall be poured flush with grade and top of unpaved areas.
3. Satisfactorily reset any valve box that is moved from its original position, preventing the operation of the valve.
4. Replace any valve box that has been damaged.

O. Identification:

1. Metallized Warning Tape: For DIP and PVC pipe (other than gravity sewer pipe and laterals) to be installed, 3-inch detectable marking tape, of appropriate color and appropriate warning statement, shall be placed along the entire pipe length. In all cases, marking tape shall be installed two feet (2') below grade or one-half the pipe's bury, whichever is less, during backfill operations (refer to Utilities Standards Manual Section 1 – 1.1 and 2.2.1). All PVC pipe, PVC fittings, and identification tape shall be color-coded per Collier County Standards. HDPE pipe installed by horizontal directional drilling will not be required to be marked with metalized warning tape.
2. Electronic Markers (see County Approved Product List, Appendix F): Install electronic markers twenty-four inches (24") below final grade, above pipe, at all bends or changes in alignment and every two hundred and fifty feet (250') along the pipe between bends.

P. Separation From Other Pipe Systems:

1. Parallel Water and Sewer or Non-Potable Lines: Sanitary sewer lines, storm sewers or force mains shall be separated from water mains by a minimum clear vertical distance of 18 inches and a horizontal distance of 10 feet. Non-potable, reclaimed or reuse water mains shall be separated from water mains, gravity sewers or force mains by a minimum clear vertical distance of 18 inches and a horizontal distance of 5 feet center to center or 3 feet outside to outside. When this standard cannot be maintained, the sewer line shall be concrete encased for a distance of 10 feet each way from the water line and any other conduit, with a minimum vertical clearance of 12 inches being provided at all times. See Section 1 - Design Criteria, Subsection 1.2.3.
2. Crossing Water and Sewer or Non-Potable Lines: Water mains crossing over a sewer or non-potable water line shall be (bottom of water main to top of sewer) separated by at least 18 inches unless local conditions or barriers

prevent an 18 inch vertical separation. All crossings with vertical clearance less than 18 inches shall be made using sewer pipe thickness Class 200 AWWA C900 PVC pipe, and water pipe of Class 51 Ductile iron pipe, for a distance of 10 feet on each side of the crossing. The gravity sewer pipe in these locations shall be backfilled with USCS Class I bedding stone to a height of 6 inches above the crown of the pipe. When water mains cross under a sewer, both mains shall be constructed of C900 Class 200 PVC pipe with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing with no intermediate joints. Additionally, a section of water main pipe shall be centered at the point of crossing. See Section 1 – Design Criteria, Subsection 1.3.

Q. Aerial Crossings:

1. Pipes spanning elevated pier crossings shall be flanged ductile iron Pressure Class 350 pipe conforming to AWWA C115, C150 & C151. Pipe spanning on piers spaced further apart than normal pipe length of 18 or 20 ft. shall be multiple length pipe with interior flanged joints with a rubber gasket pipe (see County Approved Product List, Appendix F). The pipe wall thickness and flanged joints shall be designed to safely span the elevated piers under working pressure without exceeding the allowable stresses and conform to AWWA C150. Limit pipe deflection at center of span with pipe full of water to 1/720 of span length. Provide expansion joints for between above ground and below ground wastewater lines.
2. Flanges shall conform to AWWA C150 and C115. All bolts and nuts used in aerial crossings shall be 304 stainless steel. Gaskets shall be full faced or recessed "O-Ring" type to prevent leaks in pipe under stress in the aerial crossing.
3. Outside surface of all pipe, flanges or spool pieces shall be shop coated with zinc primer, High Build Epoxy protective coat and a finish coat of polyurethane high gloss. Color shall be Federal Safety Blue for potable water mains and Pantone Purple 522 C for non-potable irrigation water mains.
4. Install operating valves or other flow regulating devices on each shoreline or at a safe distance from each shoreline to prevent discharge in the event the line is damaged.
5. Install supports for all joints in pipes utilized for aerial crossings and to prevent overturning and settlement. Expansion jointing is specified between above ground and below ground sewers and force mains.

3.3 FIELD QUALITY CONTROL

- A. Testing: Test pipelines in accordance with Section 022501.

1. Test valves in place, as far as practicable, and correct any defects in valves or connections.
 2. Gravity Sewer Lines: Test in accordance with Section 022501
- B. Inspection: Clean, inspect, and examine each piece of pipe and each fitting and special for defects before it is installed.
1. Cut away any lumps or projections on the face of the spigot end or the shoulder.
 2. Do not use any cracked, broken, or defective pieces in the work.
 3. If any defective piece should be discovered after having been installed, remove and replace this piece with a sound piece in a satisfactory manner at no increase in Contract Amount.

3.4 CLEANING

- A. General: Thoroughly clean all pipe before it is laid and keep it clean until it is accepted in the completed work.
- B. Removal of Materials: Exercise special care to avoid leaving bits of wood, dirt, and other foreign particles in the pipe. If any particles are discovered before the final acceptance of the work, remove and clean the pipe.

3.5 DISINFECTION

- A. General: Disinfect all pipelines that are to carry potable water in accordance with Section 025400.

END OF SECTION

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SECTION 330520

PIPE REMOVAL AND ABANDONMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Removal and abandonment of piping and appurtenances, wholly or in part, as required to complete Work as shown on the Drawings and specified in this Section.
- B. Related Work Specified in other Sections Includes:
 - 1. Section 020500 – Connection to Existing Systems
 - 2. Section 033100 – Concrete, Masonry Mortar and Grout
 - 3. Section 312316 – Excavation – Earth and Rock
 - 4. Section 312323 – Backfilling

1.2 SUBMITTALS

- A. General: Provide all submittals, including the following, as specified in Division 1.
- B. Submit the following:
 - 1. Proposed methods for pipe removal and abandonment;
 - 2. Equipment proposed to be used to do pipe removal and abandonment work;
 - 3. Resume of pipe grouting subcontractor;
 - 4. Pipe removal and abandonment schedule/sequence.
- C. If a detour is required, submit a traffic control plan for approval to County Manager or designee and/or the Florida Department of Transportation as described in Section 015526.

1.3 SITE CONDITIONS

- A. General
 - 1. Prior to any work, a proper and approved maintenance of traffic plan (MOT) shall be submitted to the engineer and the County.
 - 2. Execute pipe removal and abandonment so that there is no injury to persons or damage to adjacent buildings, structures, equipment, materials, piping, wiring, pavement, fences, trees, guardrails, and other adjacent improvements. Execute demolition and abandonment so that access to facilities that are in operation and to residences and businesses is free and safe.
 - 3. Execute pipe removal and abandonment so that interference to vehicular traffic and personnel traffic does not exceed scheduled interference. Do not place rubble,

excavation, piping, or other materials removed on roadways, drives, or sidewalks that are to remain in service.

PART 2 - PRODUCTS

2.1 TEMPORARY MATERIALS

- A. Provide temporary fencing, barricades, barriers, piping, valves, pumps, power and controls, and water necessary to meet the requirements of this Section.
- B. Temporary fencing, barricades, barriers, and enclosures shall be suitable to the purpose intended.

2.2 REPAIR AND REPLACEMENT MATERIALS

For repair or replacement of existing facilities or improvements to remain, use materials identical to, or equal to, materials used in existing work when new.

PART 3 – EXECUTION

3.1 GENERAL

- A. Conduct pipe removal and abandonment as shown and specified in the Contract Documents.
- B. Conduct pipe removal and abandonment so that existing equipment, piping, wiring, structures, and other improvements to remain are not damaged. Repair or replace equipment, piping, wiring, structures, and other improvements damaged at no additional cost to the County.
- C. Do not remove equipment, piping, wiring, structures, or other improvements not shown or specified to be removed. If equipment, piping, wiring, structures, or other improvements not shown or specified to be removed is removed, replace equipment, piping, wiring, structures, or other improvements at no additional cost to the County.

3.2 DISCONNECTIONS

- A. Prior to starting pipe removal or abandonment, check underground and exposed existing utilities, piping, and equipment within the limits of pipe removal or abandonment. Prior to starting, check underground and exposed existing utilities, piping connected to and associated with existing pipe to be removed or abandoned. Verify the following:
 - 1. Piping is inactive (abandoned);
 - 2. Other utilities which may be in conflict have been permanently or temporarily disconnected, if required:
- B. Do not proceed with salvage or demolition if piping is active or utilities have not been disconnected.

3.3 ABANDONMENT

- A. The Contractor shall, as described on the Drawings and as may be directed by the County, abandon in place the following existing utility improvements:
1. All water mains, reuse water mains and raw water mains that are designated to be abandoned shall be filled with grout. Refer to Section 033100 – Concrete, Masonry Mortar and Grout.
 2. All sewer lines, force mains, laterals and services that are designated to be abandoned shall be flushed clean and filled with grout. Prior to grout fill, sewer lines, force mains, laterals and services to be abandoned shall be flushed clean to remove wastewater and solids. Contractor is responsible for securing and providing flushing water, collection of flush water/wastewater, and disposal. The cleaning of these piping systems shall comply with all local and DEP requirements.
 3. Sewer manholes designated to be abandoned shall have the top two feet removed. The remainder of each manhole shall be abandoned and filled with grout or flowable fill. The excavation or pit shall be backfilled with select fill and compacted in accordance with Section 312323 – Backfilling and the trenching details on the Drawings.
- B. Appurtenances: All water hydrants, ARV valves and other appurtenances on abandoned lines shall be removed to the main and the fitting at the main shall be capped or plugged. All valves shall have the valve box, pad and operator removed, with the valve left in the open position unless specifically noted otherwise.
- C. Preparation:
1. The County shall be notified at least 72 hours in advance of grouting operations.
 2. Bulkheads shall be spaced at intervals of not more than 1,000 feet. If the line to be abandoned is longer, bulkheads shall be inserted in the pipe to maintain the required maximum spacing between bulkheads.
 3. Temporary vents shall be installed in the line to be filled at a maximum spacing of 150 ft. The vents shall be capable of being capped to allow further grouting operations.
- D. Equipment:
1. The materials shall be mixed or delivered in equipment of sufficient size and capacity to provide the desired amount of grout material for each stage in a single operation. The equipment shall be capable of mixing the grout at densities required for the approved procedure and shall also be capable of changing density as dictated by field conditions any time during the grouting operation.
 2. Mixers and Pumps - The grout shall be delivered to the injection point at a steady pressure with a non-pulsating centrifugal or triplex pump. Means shall be provided to increase or decrease the water-cement ratio. The system shall mix the grout to a homogeneous consistency. Means of accurately measuring grout component quantities, pumping pressures, and volumes pumped shall be provided.

3. Pressure Gauges - CONTRACTOR shall provide one pressure gauge at the point of injection and one pressure gauge at the grout pump. Grouting shall not proceed without appropriate calibrated gauges in place and in working order. Pressure gauges shall be equipped with diaphragm seals, have a working range between 1.5 to 2.0 times the design grout pressure, and have an accuracy within 0.5 percent of full range. Pressure gauges shall be instrument oil filled and attached to a saddle-type diaphragm seal to prevent clogging with grout.

E. Grouting:

Once grouting operations begin, grouting shall proceed uninterrupted from bulkhead to bulkhead. Grout placement shall not be terminated until both of the following conditions have been met, unless otherwise approved by the County: a) The estimated volume of grout to fill the line has been injected; and, b) grout has been expelled from the furthest vent or bulkhead. Bulkheads and temporary vents shall not be removed until the grout has set.

F. Testing and Sampling:

1. Take four test specimens for each 50 cubic yards of grout or for each four hours of placing.
2. Test in accordance with ASTM C109 except:
 - a. The specimens shall be 3 inch by 6 inch cylinders covered after casting to prevent damage and loss of moisture. Moist cure specimens for a period up to 7 days prior to a 28-day compressive strength test.
 - b. Do not oven dry specimens that are load tested. Specimens may be tested at any age to monitor compressive strength. The material may require special handling and testing techniques.

- G. The CONTRACTOR may remove the pipe in accordance with the Paragraph 3.04 in lieu of abandonment if acceptable to the County. Such removal, however, will be paid at the same price for pipe abandonment.

- H. All work under this Section shall comply with City, County, State and Federal regulations.

3.4 REMOVAL AND DISPOSAL

- A. The Contractor shall, as described on the Drawings and as may be directed by the County, remove the following existing utility improvements:

1. All water mains, reuse water mains and raw water mains that are designated to be removed.
2. All sewer lines, sewer manholes, force mains, laterals and services that are designated to be removed shall be flushed clean with water prior to removal. Contractor is responsible for securing and providing flushing water, collection of flush water/wastewater, and disposal. The cleaning of these piping systems shall comply with all local and DEP requirements.

- B. The pipe removal and disposal shall include all valves, fittings and appurtenances.

3.5 SALVAGE OF EQUIPMENT, PIPING, AND MATERIALS

- A. Remove items identified on the drawings or specified to remain the property of the County. Do not damage equipment, piping, and materials to be salvaged.
- B. Following removal of equipment, piping, and materials to be salvaged, place equipment, piping, and materials in a location within the County limits as designated by the County.

3.6 REPAIRS

Repair structural elements, equipment, piping, conduit, and other improvements to remain that are damaged during demolition. Use workers specifically qualified in trade, or trades, involved to repair damaged work.

3.7 DISPOSAL

- A. Remove and dispose of all equipment, piping, and materials from the jobsite not specifically designated to be retained by the County.
- B. Contractor shall not accumulate or store debris from demolition on the project site.
- C. The disposal of the piping, manholes and appurtenances shall be in accordance with County, State and Federal laws.

3.8 BACKFILLING

- A. Backfill excavations, trenches, and pits resulting from abandonment and removal according to Section 312323 – Backfilling.
- B. Backfill of the pipe trenches shall be according to the County details for pipe trench backfill. Pipe trenches for removed pipes that were within 3 horizontal feet of the edge of pavement shall be backfilled according to the detail for the type of roadway.

3.9 CLEANUP AND CLOSURE

- A. Following pipe abandonment or removal, clean-up areas where other work is to be done as specified in this Section, or Sections applicable to work to be done.
- B. Following pipe abandonment or removal, clean-up areas where no other work is to be done under this Contract. Remove debris and rubbish, temporary facilities, and equipment. Level surface irregularities to eliminate depressions. Leave work in a neat and presentable condition.
- C. In locations where a pipe to be abandoned or removed connects to a pipe that remains in service, the Contractor shall install a suitable cap or plug on the end of the active pipe.

END OF SECTION

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SECTION 330523.13

HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

- A. The requirements of this section are applicable to all horizontal directional drills where the carrier pipe is 3" in nominal diameter and larger.
- B. Provide all necessary tools, materials, labor, supervision and equipment to successfully complete the installation of directionally drilled piping as specified herein and shown on the drawings. The CONTRACTOR shall be responsible for the final constructed product, and for furnishing the qualified labor and superintendence necessary for this method of construction.
- C. Furnish all items necessary to perform the horizontal directional drilling operation and construct the pipe to the lines and grade shown on the drawings. Project work tasks include completion of the drilling, pulling operations, horizontal directional drilling installation pressure testing, and final connection of piping installed as part of the horizontal directional drilling to open-cut piping. Horizontal directional drilling shall include the following work elements:
 - 1. Drilling of the pilot hole and the reaming of the hole sufficient to install the HDPE pipe.
 - 2. Provide, assemble, and install HDPE pipe including:
 - a. Thermal fusion welding the HDPE pipe sections for temporary staging.
 - b. Pulling the HDPE fused pipe stringout, in a continuous pullback operation with one fuse pipe cartridge.
 - 3. Following HDPE pipe pullback, cut the HDPE pipe stubouts and install a temporary thermal fusion welded HDPE cap on both ends of the HDPE pipe stubouts, and perform pressure testing with water to verify pipeline integrity in accordance with the requirements of Section 022501 for HDPE product pipe material.
- D. Use techniques of creating or directing a borehole along a predetermined path to a specified target location. Use mechanical and hydraulic deviation equipment to change the boring course and use instrumentation to monitor the location and orientation of the boring head assembly along a predetermined course.

1. Develop, provide, and operate a Drill Fluid Loss Monitoring Program as follows:
 - a. Drill Fluid Loss Monitoring Program shall insure the following:
 - 1) Site specific storm water control measures meet the requirements of the FDEP Best Management Practices guidelines. Storm water control measures shall include, as a minimum, onsite silt fence and sandbags or other mechanical means located between the construction operations and any adjacent water body. Storm water control measures shall provide positive containment of uncontrolled fluids on the site resulting from spills or overtopping of drill pits from heavy rainfall and prevent the fluids from reaching adjacent water body, or bodies.
 - 2) Positive containment of uncontrolled fluids on the site resulting from spills or overtopping of drill pits from heavy rainfall.
 - 3) Fluids are prevented from reaching the adjacent water bodies, per FDEP ERP permit requirements.
 - b. Drill Fluid Loss Monitoring Program shall include the following:
 - 1) Observations along the drill path during drilling and reaming operations;
 - 2) Equipment for spill control remediation including, but not necessarily limited to, vac trucks, sand bags, and pumps; emergency spill and leakage control materials and equipment including diapers, absorbent material and other fuel and oil spill containment and cleanup materials;
 - 3) Drill fluid loss monitoring and containment including downhole verification of annular drill fluid pressure with continual and immediate reading capability of the pressure monitor;
 - 4) Drill rig instrumentation, including remote-monitoring electronic data recording features, to monitor drill fluid pressures and rates at pits, tanks, pumps, and drill rig operations;
 - 5) Drill fluid properties measuring equipment; and
 - 6) Trained field personnel to monitor and maintain the instrumentation.
 - c. Provide drill fluid Loss Circulation Materials (LCM's) on site ready for use if needed.
2. Equipment shall be in functional order during all drilling operations.

3. Data shall be provided to the OWNER's representative daily or on request and a complete package of the recorded data will be provided to the OWNER following completion of the drill.

- E. Accomplish drilling with fluid-assist mechanical cutting. Use a mixture of bentonite and water or polymers and additives. Use bentonite sealants and water to lubricate and seal the mini-tunnel. Use minimum pressures and flow rates during drilling operation as not to fracture the sub-grade material around and or above the bore.
- F. Utilize small diameter fluid jets to fracture and mechanical cutters to cut and excavate the soil as the head advances forward.
- G. Install an offset section of drill stem that causes the cutter head to turn eccentrically about its centerline when it is rotating for steering. When steering adjustments are required, rotate the cutter head offset section toward the desired direction of travel and advance the drill stem forward without rotation. Control of tunnel line and grade shall meet the requirements of this section.
- H. The mobile drilling system shall be capable of being launched from the surface at an inclined angle and drilling a pilot hole with a diameter appropriate to the size, length, and configuration of the directional drill. The pilot hole shall then be enlarged with reamers as required. Pilot holes are not required on drills 4" and smaller.
- I. Develop and provide certified as-built plans, signed and sealed by a Professional Land Surveyor licensed in the State of Florida, in accordance with this Section

1.2 REFERENCE STANDARDS

- A. See Section 330502 for casing and carrier pipe diameter requirements.
- B. American Association of State Highway and Transportation Officials (AASHTO).
- C. Occupational Safety and Health Administration (OSHA).
- D. ASTM Standards:
 - 1. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
 - 2. ASTM F 1962 Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings

1.3 DEFINITIONS

- A. CONTRACTOR's Construction Drawings shall be defined as drawings by which the CONTRACTOR proposes to construct, operate, build, etc., the referenced item. Submit Construction Drawings for the sole purpose of providing the sufficient details to verify that the CONTRACTOR's work in progress is in accordance with the intent of the design.

1.4 SUBMITTALS

- A. The ENGINEER will base the review of submitted details and data on the requirements of the completed work, safety of the work in regards to the public, potential for damage to public or private utilities and other existing structures and facilities, and the potential for unnecessary delay in the execution of the Work. Such review shall not be construed to relieve the CONTRACTOR in any way of his responsibilities under the contract. Do not commence work on any items requiring CONTRACTOR's Construction Drawings or other submittals until the drawings and submittals are reviewed and accepted by the ENGINEER.

- B. The CONTRACTOR shall:

1. Submit for review complete construction drawings in plan and profile view identifying details of the proposed method of construction and the sequence of operations to be performed during construction only if deviations from the contract plans are proposed. The drawings shall be sufficiently detailed to demonstrate to the ENGINEER whether the proposed materials and procedures will meet the requirements of the Contract Documents.
2. Submit manufacturer's data for the HDPE pipeline, as outlined in Section 330502 for HDPE product pipe material.
3. Submit the directional boring locating equipment proposed for use, method of locating to be used, and the proposed sequence and method of construction, for approval by the ENGINEER in accordance with the plans and specifications. Include information on how the bore is to be steered, the information recorded, and the pipe location verified for record drawings. Include proposed pilot bore tunnel size, proposed drilling fluid composition and Material Safety Data Sheets (MSDS), proposed viscosities, proposed pre-ream procedures, and final tunnel size. Submit proposed Temporary Traffic Control (MOT) plans for FDOT right-of-way work and for Collier County DOT right-of-way work.
4. Submit a work sequence and schedule. Provide a list of key personnel for the project including superintendent, driller, and tracking specialists.
5. Prior to approval for directional boring, the CONTRACTOR shall submit the names of supervisory field personnel and historical information of directional boring experience.

6. Drill Method Submittal: Submit a minimum of 20 days before starting drilling for review and approval. This submittal shall include the following information:
 - a. Drawings. Submit scaled plan showing the following: the work zone equipment configuration at each end of the drill; staging and storage areas; and the location of drill fluid, HDPE pipe, water supply for drilling, cuttings, pit spoil handling areas; and storm water containment measures, devices and locations.
 - b. Drilling Procedure. It is recognized and accepted that the CONTRACTOR may need to adjust drilling procedures and equipment as new information is developed during the drill. The intent of this requirement is to provide the CONTRACTOR's initial approach to the project specific subsurface and permit conditions.
 - c. Maximum Pipe Pull-back Forces: Submit anticipated maximum pipe pull-back forces based on proposed drill path plan and profile.
 - d. Drill Fluid Loss Monitoring/Frac-Out Plan. Submit materials list including bentonite and bentonite additives for the project along with respective MSDS for all materials used on the site.
7. Tracking Coordination Submittal: Provide this submittal a minimum of 20 days prior to drilling. The intent of this submittal is to coordinate the contractor activities with the tracking specialist. Include manufacturer's data sheets and calibration on the tracking equipment and sample data recording log sheets.
8. The CONTRACTOR shall bring to the attention of the ENGINEER any known design issues based on CONTRACTOR's proposed drilling methods and/or procedures. This shall be stated in writing to the ENGINEER no later than the preconstruction meeting.
9. CONTRACTOR's construction drawings shall be submitted on the following items only if deviations from the Contract plans are proposed.
 - a. Proposed contingency plans for critical phases and areas of directional drilling.
 - b. Any proposed deviations from the Contract construction plans.
 - c. Any proposed deviations from the Contract construction specifications.
10. Quality Control Methods. CONTRACTOR shall submit a description of his quality control methods he proposes to use in his operations to the ENGINEER. The submittal shall describe:

- a. Procedures for controlling and checking line and grade.
- b. Equipment specifications for checking line and grade.
- c. Field forms for establishing and checking line and grade.
- d. Actual product pipe pullback forces.

1.5 QUALITY CONTROL

- A. Low Pressure Air Test. Before the OWNER accepts the installation of each HDD, the CONTRACTOR shall perform a low-pressure air test of each of the HDPE fused pipe string-out cartridges prior to pipe pullback. Low pressure testing of the above ground pipes to be 10 psig for 60 minutes duration, soap all joints to test for leaks, and test pressure to remain within 2 PSI of original applied pressure for acceptance.
- B. Annular Pressure Monitoring. Annular pressure shall be monitored and recorded using equipment constructed for that purpose, and shall include a fully-instrumented remote-monitoring data recording package, such as PASON or equal. Annular pressures shall be monitored and recorded in the Annular Pressure Report. Annular pressure shall be recorded during active drilling of the pilot hole and during the first ream pass. The minimum and maximum annular pressure experienced during the joint shall also be recorded; the minimum and maximum pressures are not necessarily the pressures recorded at the start, middle and end of each joint, but shall be maximum values as measured throughout the whole joint. The time of each recorded measurement shall be recorded. The annular pressure measurements shall be indexed to the rod being drilled. The trends of the circulating pressure information will be assessed and corrective action shall be taken when appropriate. Drilling shall be stopped when required to prevent excess annular pressure. Drilling may resume once the cause of the excess down-hole pressure has been identified and corrected.
- C. Pipe Pull-back Forces. Force applied to pipe during pull-back shall not exceed the values shown on the Drawings.
- D. ENGINEER Authority for Directional Drilling. Directional drilling shall be performed in accordance with approved submittals. ENGINEER will have the authority to interpret and make decisions with respect to drilling activities should specification interpretation be required or unanticipated conditions occur.

1.6 JOB CONDITIONS

- A. Safety Requirements
 - 1. Perform work in a manner to maximize safety and reduce exposure of men and equipment to hazardous and potentially hazardous conditions, in accordance with applicable safety standards.

2. Whenever there is an emergency or stoppage of work which is likely to endanger the excavation or adjacent structures, operate a full work force for 24 hours a day, including weekends and holidays, without intermission until the emergency or hazardous conditions no longer jeopardize the stability and safety of the work.

B. Air Quality.

1. Conduct directional drilling operations by methods and with equipment, which will positively control dust, fumes, vapors, gases or other atmospheric impurities in accordance with applicable safety requirements.

C. Geotechnical Investigation

1. Make any geotechnical investigations deemed necessary to determine actual site conditions.

D. Unanticipated Conditions

1. Notify ENGINEER of unexpected subsurface conditions and discontinue work in affected area until notified by ENGINEER to resume work.
2. Take emergency measures as required to protect persons and improvements.

1.7 UTILITY PROTECTION

- A. Utility lines and structures indicated on the drawings, which are to remain in service, shall be protected by the CONTRACTOR from any damage as a result of their operations. Where utility lines or structures not shown on the drawings are encountered, the CONTRACTOR shall report them to the ENGINEER before proceeding with the work. The CONTRACTOR shall bear the cost of repair or replacement of any utility lines or structures, which are broken or damaged by their operations.

- B. All utilities that may be impacted by the HDD shall be exposed through a "pot-hole" or other opening, in accordance with state utility locate laws and regulations, to ensure, through visual inspection, that the drill, reamer, or product pipe will not cause damage to the utility.

1.8 PERMITS

- A. Obtain any and all other permits required for prosecution of the work.

PART 2 PRODUCTS

2.1 GENERAL

- A. Refer to Section 330502 for HDPE pipe material.
- B. Use a high quality bentonite drilling fluid or equivalent to ensure hole stabilization, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Oil based drilling fluids or fluids containing additives that can contaminate the soil or groundwater will not be considered acceptable substitutes. Composition of the fluid shall comply with all federal and local environmental regulations.
 - 1. Disposal of drilling fluids shall be the responsibility of the CONTRACTOR and shall be conducted in compliance with all relative environmental regulations, right-of-way and workspace agreements and permit requirements.
 - 2. Drilling fluid returns can be collected in the entrance pit, exit pit, or spoils recovery pit. The CONTRACTOR shall immediately clean up any drilling fluid spills or overflows from these pits.

PART 3 EXECUTION

3.1 GENERAL

- A. The CONTRACTOR shall be responsible for his means and methods of directional drilling construction and shall ensure the safety of the work, the CONTRACTOR's employees, the public, and adjacent property, whether public or private.
- B. Obtain locations of all existing utilities within the horizontal directional drilling project area, whether shown on the plans or not, in coordination with the owners of such utilities. Be responsible for protection of such utilities from damage, and repair of any utilities damaged during or as a result of construction.
- C. Anticipate that portions of the drilled excavation will be below the groundwater table.
- D. Comply with all local, state and federal laws, rules and regulations at all times to prevent pollution of the air, ground and water.
- E. A pilot hole shall be drilled such that the required vertical clearances from ditch, river, or wetland bottoms and utilities and horizontal clearances from jurisdictional or buffer lines and utilities are maintained. If the pilot hole exits in jurisdictional or buffer areas they shall be responsible to grout hole to satisfaction of the environmental regulators and the ENGINEER.

- F. The boring hole shall then be reamed to be 120% to 150% oversized than the HDPE product pipe OD. Drilling mud, usually fluidized bentonite clay, shall be used to stabilize the hole and remove soil cuttings. The CONTRACTOR shall monitor and record the reamed hole location and depth at the same intervals as the bore hole.
- G. The pull-back operations shall include pulling the entire pipe stringout, in one segment back through the reamed hole and drilling mud. The pull-back operations shall include filling the product pipe with water to reduce the buoyancy and to reduce the pull-back forces required to pull-back the product pipe in the borehole. Proper pipe handling, cradling, bending minimization, surface inspection, and fusion welding procedures (for HDPE) shall be followed in accordance with this specification and Section 330502. Note that anticipated pullback speed is typically 1 to 2 feet per minute. Pull-back operation shall be continuous with no stoppage. If conditions exist where the pull-back cannot be continuous, the Contractor shall submit an alternative plan to the Engineer for review and approval prior to commencing the drill.
- H. Any soil borings required for the CONTRACTOR's detailed designs shall be included in the bid. The CONTRACTOR is fully responsible to obtain this information.
- I. CONTRACTOR shall be responsible for design and construction of the drill entrance and exit pits. Supports may be required to maintain safe working conditions, ensure stability of the pit, minimize loosening, and minimize soil deterioration and disturbance of the surrounding ground.
- J. CONTRACTOR shall be required to locate all utilities prior to start of excavation or drilling. All utilities crossed or approached within 48 inches in a lateral direction shall be exposed to verify location. In addition, visual verification shall be required that the drill, reamer, or product pipe has missed the utility as it passes. Damage to utilities shall be the responsibility of the CONTRACTOR.
- K. Immediately upon completion of work, all rubbish and debris shall be removed from the job site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat, clean, and acceptable condition.
- L. "Frac-outs" or "Blow holes" of drilling fluid to the surface shall be immediately reported to the ENGINEER and the OWNER's representative, and shall be cleaned up immediately and the surface area washed and returned to original condition. All drilling fluids, spoils, and separated material shall be disposed of in compliance with federal and local environmental regulations.

- M. If, during boring, an obstruction is encountered which prevents completion of the bore in accordance with the design location and specification, and the product pipe is abandoned in place and taken out of service, the failed bore shall be filled with cement grout. The record drawings shall show the failed bore path along with the final bore path on the as-built plans. Should the HDD crossing be lost or damaged while the CONTRACTOR is engaged in the performance of the work, all such lost or damage to the hole shall be borne by the CONTRACTOR. Failure to complete the crossing or partially completed crossing by directional drilling or as approved by ENGINEER and OWNER will result in forfeiture of all payment.

3.2 EQUIPMENT

- A. Diesel, electrical, or air-powered equipment will be acceptable, subject to applicable federal and state regulations.
- B. Any method or equipment that the CONTRACTOR can demonstrate will produce the specified results will be considered.
- C. Employ equipment that will be capable of handling the various anticipated ground conditions. In addition, the equipment shall:
1. Be capable of minimizing loss of ground ahead of and around the machine and providing satisfactory support of the excavated face at all times.
 2. Provide a system to indicate whether the amount of earth material removed is equivalent to that displaced by the advance of the machine such that the advance rate may be controlled accordingly.
- D. Provide adequate secondary containment for any and all portable storage tanks.
- E. Provide down-hole annular pressure monitoring equipment, including remote monitored electronic data recording package, such as PASON, or equal.

3.3 DIRECTIONAL DRILLING DATA

- A. Submit daily logs of construction location, progress and events, including observations on the following:
1. Drill thrust pressure.
 2. Drill pullback pressure.
 3. Annular pressure.

3.4 CONTROL OF THE TUNNEL LINE AND GRADE

A. Construction Control.

1. Establish and be fully responsible for the accuracy of control for the construction of the pipeline to be installed, including structures, tunnel line and grade.
2. Establish control points sufficiently far from the tunnel operation so as not to be affected by construction operations.
3. Maintain daily records of alignment and grade and submit three copies of these records to the ENGINEER. However, the CONTRACTOR remains fully responsible for the accuracy of his work and the correction of it, as required.
4. Check, monitor, and record control for the bore alignment against an above ground undisturbed reference at least once each hour and at least once for each drill rod length interval. CONTRACTOR shall immediately report bore alignment location to ENGINEER after each control check. The location shall be reported based on the approved bore alignment, i.e. horizontal distance and direction from approved bore alignment and vertical distance and direction from approved bore alignment length from the entry or exit point along the bore path, and horizontal distance from the entry or exit point.
5. The pilot hole shall be drilled on bore path with no deviations greater than 10 percent of depth of the bore path as shown on the Drawings or approved CONTRACTOR submittal drawings. In the event that pilot hole deviates from bore path more than 10 percent of depth, CONTRACTOR shall notify ENGINEER and ENGINEER may require CONTRACTOR to pull-back and re-drill from the location along bore path before the deviation. The depth of the bore path is the vertical distance from the drill head to the surface of the earth, i.e. ground, pavement, water surface. Any deviations greater than 10 percent shall be reviewed by the ENGINEER. Excessive deviation may be grounds for rejection of the bore. All minimum vertical separations and clearances must be maintained regardless of the allowable drill path deviations.
6. Pilot hole shall be drilled on bore path with no deviations greater than 10 feet horizontally along the path of the drill. Excessive deviation may be grounds for rejection of the bore. Regardless of the tolerance achieved, right-of-way and easement restrictions shall take precedence over the listed tolerances. Listing of tolerances does not relieve CONTRACTOR from responsibility for safe operations or damage to adjacent utilities and structures.

7. Record survey of the pilot hole shall be submitted in State Plane Coordinate system using NAVD 1988 datum.

3.5 INSTALLATION OF TRACKING/LOCATING WIRE

- A. Install all facilities such that their location can be readily determined by electronic designation after installation. For non-conductive installations, attach a minimum of two (2) separate and continuous conductive tracking (tone wire) materials, either externally, internally or integral with the product. The ends of the tone wire shall be stubbed up through a one-inch (1") diameter SCH 80 PVC pipe which shall be installed in the concrete valve pad adjacent to the valve box on both sides of the directional drill. Use either a continuous green-sheathed solid conductor copper wire line (minimum #12 AWG for external placement or minimum #14 AWG for internal placement in the conduit/casing) or a coated conductive tape. Conductors must be located on opposite sides when installed externally. Connect any break in the conductor line before construction with an electrical clamp, or solder, and coat the connection with a rubber or plastic insulator to maintain the integrity of the connection from corrosion. Clamp connections must be made of brass or copper and of the butt end type with wires secured by compression. Soldered connections must be made by tight spiral winding of each wire around the other with a finished length minimum of three (3) inches overlap. Test conductors for continuity. Each conductor that passes must be identified as such by removing the last six (6) inches of the sheath. No deductions are allowed for failed tracking conductors. Conductor ends must be stubbed out through the PVC conduit at the isolation valve box at the terminus of the drill.

3.6 DEWATERING

- A. Where such effort is necessary, cost for groundwater control during the course of the directional drilling work shall be included in the unit contract price for the work.
- B. Dewatering required during the course of the project to lower water table, to remove standing water, surface drainage seepage, or to protect ongoing work against rising waters or floods shall be considered incidental to the work being performed.

3.7 DISPOSAL OF EXCESS MATERIAL

- A. Dispose of excess material, including, but not necessarily limited to, drill fluid, casing water, cuttings and pit spoil, off of the project site.
- B. Non-hazardous waste meeting the requirements of a Class III Waste shall be disposed of in a FDEP permitted Class III Landfill.

- C. Non-hazardous waste meeting the requirements of a Class I or II waste shall be disposed of in a FDEP permitted Class I or Class II landfill.

3.8 DOCUMENTATION REQUIREMENTS OF RECORD DRAWINGS

- A. Provide the ENGINEER a complete set of As-Built Plans showing all bores (successful and failed) within 30 calendar days of completing the work. Ensure that the plans are dimensionally correct copies of the Contract plans and include utility and/or topography plan and profile, cross-section, boring location and subsurface conditions as directed by the ENGINEER. As-Built Plans shall show appropriate elevations and be referenced to two permanent benchmarks as shown on the drawings, and in a State Plane grid system and NAVD 88 datum, as designated on the Contract plans. As-Built Plans shall be same scale in black ink on white paper, of the same size and weight as the Contract Drawings. Submittal of electronic plans data in addition to hard copy plans is required and shall be compatible with the industry standard CAD software. As-Built Plans shall be signed and sealed by a Professional Land Surveyor licensed in the State of Florida. Specific plans content requirements include but may not be limited to the following:
 - 1. The Contract plan view showing the center line location of each facility installed, or installed and placed out of service, to an accuracy of 0.1 feet at the ends and other points physically observed in accordance with the bore path report.
 - 2. As directed by the ENGINEER, provide a plan and profile for each bore path. Show the ground or pavement surface and center line elevation of each facility installed, or installed and placed out of service, to an accuracy of within 0.1 feet at the ends and other exposed locations. Each bore path shall be depicted on the Contract plans using the same datum as the Contract plans.
 - 3. Show the top elevation, diameter and material type of all utilities encountered and physically observed during the subsoil investigation. For all other obstructions encountered during a subsoil investigation or the installation, show the type of material, horizontal and vertical location, top and lowest elevation observed, and note if the obstruction continues below the lowest point observed.
 - 4. Include bore notes on each plan stating the final bore path diameter, product pipe diameter and type, drill entry and exit angles, and installed bore path radius for each pipeline installed by HDD.

3.9 CLEANING

- A. General. Directional drilling operation site cleaning shall meet the requirements of Section 017423 Cleaning.

- B. Spillage. Clean spillage, on adjacent streets, from construction operations on a daily basis, if spillage occurs.

END OF SECTION

SECTION 330523.16

JACKING, AUGERING AND MINING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Pipeline installation in casing pipe beneath highways, railroads and other structures may be installed by jacking and augering or by jacking and mining.
- B. Related Work Specified in Other Sections Includes:
 - 1. Section 033100 – Concrete, Masonry, Mortar and Grout
 - 2. Section 312316 – Excavation - Earth and Rock
 - 3. Section 314000 – Shoring, Sheet piling and Bracing

1.2 REFERENCES

- A. Codes and standards referred to in this Section are:
 - 1. ASTM C 76 - Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
 - 2. ASTM A 139 - Specification for Electric-Fusion (Arc) -Welded Steel Pipe (NPS in 4 in. and Over)
 - 3. OSHA PL-91-596 - Occupational Safety Health Act of 1970 Public Law 91-596

1.3 SUBMITTALS

- A. Provide all submittals, including the following, as specified in Division 1.
 - 1. Working drawings of the jacking pipe, jacking frame, jacking head, reaction blocks, sheet piling, including design calculations and the complete jacking installation.
 - 2. Necessary permit applications and approvals by the appropriate authority.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle all products and materials as specified in Division 1.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Use the following for casing piping.
 - 1. Spiral Weld or smooth wall steel pipe, meeting the requirements of ASTM A 139, Grade B. The minimum casing pipe size shall be determined by maintaining a minimum of a four inch (4") difference between the carrier pipe's largest outside diameter (including restraints) and the casing pipe's inside diameter. The wall thickness shall be a minimum of .25 inches for up to twenty inch casings, .312 inches for twenty-four to thirty-six inch casings, and .50 inches for forty-two inch and larger casings. For special design considerations, obtain approval from Collier County Utilities.
- B. Fill Material: Use fill material consisting of 1-1/4 pounds of Bentonite per gallon of water during jacking to fill any voids between pipe and the earth.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Casing Pipe:
 - 1. Install all casing pipe in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.
 - 2. The provisions of this section shall represent the minimum standards for the installation of casing pipe for sewer force main or water main pipeline.
 - 3. Install all sewer force mains and water mains in a casing to be placed under all present and future Collier County Department of Transportation & Engineering roadways. Conform steel casing procedures to the requirements of Collier County DOT. All work and materials shall be subject to inspection by DOT. Restore the Department's property and surface conditions to the original condition in keeping with the Department's specifications and standards.
 - 4. In general, install all underground sewer force mains and water mains crossing all existing Collier County roadways, Florida State Highways and railroads within steel casing pipe extending at least five (5) feet beyond pavement edge. Obtain specific crossing requirements in advance from the authority having jurisdiction.
 - 5. Submit the necessary permit documents and data to the appropriate authority and receive approval thereof. Maintain traffic on the roadway and

keep all workmen and equipment clear of the travelway during the work. Comply with all Federal, State and County safety regulations and any permit(s).

6. Locate casing pipes crossing under State and County roadways at suitable approved alignments in order to eliminate possible conflict with existing or future utilities and structures with a minimum 36 inches depth of cover between the top of the casing pipe and the surface of the roadway. Conduct boring operations in such a manner as not to create hazardous conditions or impede traffic flow.
7. For casing pipe crossing under roadways, railroads, or other installations not within the jurisdiction of Collier County, comply with the regulations of said authority in regard to design, specifications and construction. State Highway casing installations shall be as specified in the FDOT, "Utility Accommodation Guide", and for railroads, the American Railway Engineering Association, Part 5, Section 5.2, "Specifications for Pipelines Conveying Nonflammable Substances", shall be applicable. However, in no case shall the minimum casing pipe diameter and wall thickness, for a specific carrier pipe size, be less than that specified above.
8. Use a simultaneous and continuous installation of any dry boring and jacking operation until the casing pipe is in final position. Maintain correct line and grade. Use full-ring welded add-on sections of casing pipe, developing water-tight total pipe strength joints. Use pipe lengths of at least 18 feet. Casing welders shall be certified welders. A copy of the certification shall be obtained by the Engineer of Record and given to the County Manager or designee prior to the welding procedure. Produce no upheaval, settlement, voids, cracking, movement or distortion of the existing roadbed or other facilities during the casing installation. Fill any voids with 1:3 portland cement grout at sufficient pressure for roadway protection. Following placement of the carrier pipe within the steel casing, install masonry plugs at each open end. Plugs shall be suitable for restraining the external earth load, while allowing internal drainage.
9. Mechanically bore casing pipe holes through the soil by a cutting head on a continuous auger mounted inside the pipe. Extend the auger a maximum of 2 inches beyond the end of the casing pipe to preclude formation of voids outside the pipe shell. Auger should not be of a greater diameter than the outside diameter of the encasement.
10. Adequately protect the casing pipe to prevent crushing or other damage under jacking pressures. Provide backstops for adequately distributing the jack thrust without causing deformation of the soil or other damage. Replace damaged casing pipe if not installed; however, if installed, abandon encasement pipe in place, suitably plug, and install an alternate installation, as directed by the County Manager or designee.

11. In the event of obstruction, withdraw auger, cut and cap excess pipe and fill void with 1:3 portland cement grout under sufficient pressure
12. Excavate and maintain required boring or jacking pits or shafts to the minimum dimension. Adequately barricade, sheet, brace and dewater excavation as required.
13. Deviation from approved jack and bore methods and above specifications is grounds for work stoppage and line replacement at the expense of the CONTRACTOR.

B. Casing Spacers:

Use Stainless Steel Casing Spacers (see County Approved Product List, Appendix F) being on center and restrained as the preferred method for installing the carrier pipe. Use skids installed with 6 ft to 10 ft spacing as recommended by the manufacturer. After the carrier pipe has been tested for leakage, block the casing ends with either an 8" wall of brick masonry with a weep hole installed near the bottom of each wall or casing spacer end seals (see County Approved Product List, Appendix F) with stainless steel bands.

- C. Augering: Conduct augering with the proper equipment and procedure such that the carrier pipe and the casing pipe can be installed to the grades specified without disturbing the adjacent earth. Submit all equipment and procedures for prior approval.
- D. Hand Mining: Conduct hand mining only in casings that are sufficiently large enough to permit such operation. Provide adequate fresh air supply within the casing pipe and conduct all operations in accordance with the requirements of the U.S. Department of Labor Safety and Health Regulations for Construction promulgated under the Occupational Safety and Health Act 7 1970 (PL-91-596).
- E. Jacking Pit: Make the jacking pit of adequate length to provide room for the jacking frame, the jacking head, the reaction blocks, the jacks, auger rig, and the jacking pipe. Make the pit sufficiently wide to allow ample working space on each side of the jacking frame. Make the depth of the pit such that the invert of the pipe, when placed on the guide frame, is at the elevation desired for the completed line. Provide excavation in conformance with Section 312316.
- F. Sheet piling: Sheet the jacking pit tightly and keep it dry at all times. Conform sheet piling to Section 314000. Have complete design calculation for sheet piling the jacking pit sealed and submitted by a Professional Engineer registered in the State of Florida.
- G. Jacking Frame: Use a jacking frame that applies a uniform pressure over the entire pipe wall area of the pipe to be jacked.

- H. Reaction Blocks: Use reaction blocks designed to carry the thrust of the jacks to the soil without excessive soil deflection and in such a manner as to avoid any disturbance of adjacent structures or utilities.
- I. Operation: Use hydraulic jacks in the jacking operation. Use extreme care to hold the pipe to exact line and grade. Advance the excavation at the heading manually or with an auger. Do not allow the advance to exceed one foot ahead of the casing pipe. Make every effort to avoid loss of earth outside the casing.
- J. Safety Railing: Provide a safety railing all around the top of the pit at all times.
- K. Restore property and surface conditions to the original condition in accordance with Collier County DOT specifications and standards.
- L. Carrier Pipe:

Utilize joint restrained pipe for the entire water main or force main pipe length inside the casing. Use special supporting of the carrier pipe within the casing with a design approved by the County Manager or designee.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 331200
WATER VALVES AND APPURTENANCES

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.

1.2 REFERENCES

- A. Codes, specifications, and standards referred to by number or title form a part of this Section to the extent required by the references to codes, specifications, and standards. Latest revisions, as of the date of bid opening, apply, unless otherwise noted on the Drawings or specified in this Section.

- B. Standards

<u>Designation</u>	<u>Title</u>
ANSI/AWWA C111/A21.11	Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
ANSI/AWWA C500	Gate Valves
ANSI/AWWA C509	Resilient-Seated Gate Valves 3 through 12 NPS, for Water and Sewage Systems
ANSI/AWWA C512	Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
ANSI/B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 125
ANSI/B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI/B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ASTM A276	Specification for Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A231	Specification for Steel Casting, Austenitic, for High-Temperature Service

ASTM A743	Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Corrosion-Resistant for General Application
MSS SP-60	Connecting Flange Joint Between Tapping Sleeves and Tapping Valves

1.3 DEFINITIONS

- A. References to valve sizes on the Drawings and in the Specifications are intended to be nominal size, and shall be interpreted as nominal size.

1.4 SUBMITTALS

- A. General: as specified in:
 - 1. General Conditions;
 - 2. Supplementary General Conditions;

1.5 QUALITY ASSURANCE

- A. Testing: Test valves as specified in this Section.

PART 2 PRODUCTS

2.1 GENERAL:

- A. All valves and appurtenances shall be of the size shown on the Drawings and if possible all equipment of the same type shall be from one manufacturer.
- B. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters on the body.
- C. All stainless steel components and hardware shall be a minimum of Type 304, unless otherwise specified.

2.2 MANUFACTURERS (SEE COUNTY APPROVED PRODUCT LIST, APPENDIX F).

2.3 DESIGN

- A. Resilient, Wedge or Gate Valves and Boxes
 - 1. Valves for pipe less than 2 inches in diameter shall conform to the requirements of AWWA C509 (latest revisions) and shall be cast iron, single wedge, non-rising stem, screwed bonnet, 125 pounds S.P., 200 pounds W.O.G with stuffing box repackable under pressure and all parts renewable.

Ends shall be as shown or indicated on the drawings. For approved air release line valves, bacterial sampling station line valves, curb stops, corporation stops, and ball valves see County Approved Product List, Appendix F.

2. Resilient, wedge or gate valves 2 inches in diameter and larger shall be ductile iron body, non-rising stem, bronze mounted gate valves, mechanical joint conforming to requirements of the AWWA C515 and shall be provided with a 2 inch square operating nut with the word "open" and an arrow cast in the metal to indicate direction. Valves shall be vertical resilient, wedge, or gate type and shall turn to the left (counter clockwise) to open. The wedge or gate shall be ductile iron per ASTM A536, minimum 65,000-psi strength and, completely encapsulated with urethane rubber, permanently bonded to the wedge or gate to meet ASTM test for rubber metal bond, ASTM D429. The valve stems for non-rising stem assemblies shall be cast bronze with integral collars in full compliance with AWWA. OS & Y stems shall be on bronze bar stock. The NRS stem stuffing box shall be the O-ring seal type with two rings located above thrust collar; the two rings shall be replaceable with valve fully open and subjected to full rated working pressure. The minimum safe working pressure shall be 200 psi. All valves thirty inches (30") or larger shall have a concrete slab placed under the valve to help distribute the total weight of the valve and reduce line sagging. The concrete slab shall have 6"x6" 10/10 welded wire mesh, have lifting eyes, constructed using 3,000 psi concrete, be six inches (6") thick, and sized according to the following table:

Valve Size	Length	Width
<u>30"</u>	42"	30"
<u>36"</u>	48"	36"
<u>42"</u>	54"	42"
<u>48" – 54"</u>	60"	48"
<u>60" – 66"</u>	78"	60"

3. There shall be two low torque thrust bearings located above and below the stem collar. The stem nut shall be independent of wedge and shall be made of solid bronze. There shall be a smooth unobstructed waterway free of all pockets, cavities and depressions in the seat area. The body and bonnet shall be coated with fusion-bonded epoxy both interior and exterior. Each valve shall have the manufacturers name, pressure rating and year manufactured cast on body. The valve shall be designed and tested to be opened and closed under a differential pressure of at least twice the working pressure.

B. Valves for Buried Service

1. Valves for buried service shall meet all the requirements as specified herein but shall have mechanical joint ends and stainless steel cover bolts.

2. All buried valves shall have cast-iron two-piece valve boxes (see County Approved Product List, Appendix F). Valve boxes shall be provided with suitable heavy bonnets to extend to such elevation at the finished grade surface as directed by the ENGINEER. The barrel shall be two-piece, screw type. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling, shall be designed so as to prevent the transmission of surface loads directly to the valve or piping, and shall be complete with cast iron covers. Covers shall have "WATER" cast into the top. The covers shall be so constructed as to prevent tipping or rattling. All valve boxes located in paved roadways or sidewalks shall have locking covers.
3. Where valves are located out of pavement, the boxes shall be adjusted to finished grade with a concrete collar as shown in the Details.
4. Valve boxes shall be of the heavy duty, traffic bearing cast iron, adjustable screw type with a drop cover. The valve box assembly shall consist of a bottom section, top section and cover which is cast from gray iron, formulated to ASTM specification A-48 latest revision, minimum tensile of 21,000 psi and shall be free from blowholes, shrinkage or other imperfections not true to pattern. The shaft size shall be 5 1/4" and the adjustable length shall be from 18" to 36". The wall thickness shall be 1/4". The weight of the assembly shall be 61 pounds $\pm$ 2 pounds, with the cover weight being a minimum of 13 pounds.
5. The name of the manufacturer and foundry of origin shall be cast into each of the components of the assembly in legible form. The assembly shall be suitable for highway traffic wheel loads of 16,000 pounds and shall withstand a proof load test of 25,000 pounds without failure or permanent deflection.

C. Check Valves

1. All check valve bodies shall be cast iron per ASTM A126 Class B, having integral (not wafer) flanges.
2. The seat shall be centrifugally cast bronze with an O-ring seal and be locked in place with stainless steel lock screws and be field replaceable, without the use of special tools.
3. Swing check valves shall have a shaft of single and continuous stainless steel, extending both sides of the body with a lever and weight. The air cushion cylinder, when specifically required, shall be constructed of corrosion resistant material and the piston shall be totally enclosed within the cylinder and not open at one end. The air cushion cylinder assembly shall be externally attached to either or both sides of the valve body and shall permit adjustability to cushion the closure of the valve. Cushioning shall be by air trapped in the cushion cylinder, which shall be fitted with a one-way adjustable control check valve to cushion disc contact to the seat at

the shut-off point. The bottom cylinder head shall be swivel mounted and not rigid to follow the change of force angles as the lever raises or lowers to open or close the check valve. Valve shall prevent backflow on normal pump shut off or power failure, at zero velocity and be watertight. The disc shall be cast iron utilizing a double clevice hinge connected to a ductile iron disc arm. The disc arm assembly shall be suspended from a stainless steel shaft, which passes through a seal retainer on both sides of the valve body.

4. Rubber flapper swing valves shall have a heavily constructed cast iron body and cover. The body shall be long pattern design (not wafer) with integrally cast-on end flanges. The flapper shall be Buna-N having an O-ring seating edge and be internally reinforced with steel. Flapper shall be captured between the body and the body cover in a manner to permit the flapper to flex from closed to full open position. Flapper shall be easily removed without the need to remove the valve from line. The check valves shall have full pipe size flow area. Seating surface to be on a 45° angle requiring the flapper to travel only 35° from closed to full open position for minimum head loss. Valve has non-slam closure characteristics. Flapper shall create an elastic spring effect to assist the flapper to close against a slight head to prevent or minimize slamming. Valve shall be designed for 175 psi working pressure for water. The valve shall be suitable for buried service.
 5. Valve exterior to be painted with Red Oxide Phenolic Primer Paint as accepted by the FDA for use in contact with Potable Water. Materials shall be certified to the following ASTM specifications:
 - a. Body, cover & disc - Cast Iron - ASTM A126, Class B
 - b. Disc Arm - Ductile Iron - ASTM A536
 - c. Seat - Aluminum Bronze or Stainless Steel - ASTM B148, ASTM A276
 - d. Disc Seat - Buna-N or metal
 - e. Cushion cylinder - Corrosion-resistant Commercial material
- D. Backflow Prevention Devices
1. Backflow prevention devices shall be reduced pressure principle assemblies and shall be USC approved, and shall meet all requirements of the Collier County Cross-Connection Control/Backflow Prevention Ordinance, as then amended. Refer to Section 3, Utility Detail Drawings.
- E. Combination Air Release Valves for Potable Water and Non-Potable Irrigation Systems
1. Air release valves shall exhaust large quantities of air during the filling of a pipeline or vessel. The valve shall be capable of venting air up to sonic

velocity without blowing shut; closing only after all the air has been vented. The valve shall continue to release small quantities of air under pressure as often as needed to keep the system free of accumulated air. The valve shall automatically open to allow air to re-enter during draining or whenever a negative pressure occurs.

2. Combination air valves shall be of the size shown on the plans and conform to the requirements of AWWA C512 and be of the "Kinetic" design capable of exhausting air at up to sonic velocity without blowing shut.
3. Body and cover shall be ASTM A126 Class B cast iron with stainless steel floats and replaceable seats of Buna-N or other suitable material. Internal linkage mechanism shall be 18-8 stainless steel. Plastic or bronze components are not acceptable. Air release orifice shall be suitable for 300 PSI maximum working pressure. Screens shall be installed on the opening of all air release valves.
4. Valves 3-inch size and smaller shall have a threaded inlet connection, and larger valves shall have a flanged inlet faced and drilled per ANSI B16.1 Class 250.
5. Valves shall have a threaded outlet on valves to 4-inch size and a protective cowl on larger sizes.
6. 1 inch NPT inlet and outlet shall be provided, unless otherwise specified on the drawings.
7. Connections from corporation stops to air release valves shall be brass for rigidity.

F. Tapping Valves and Sleeves

1. All tapping sleeve and valve assemblies shall meet the requirements of AWWA Standard C500, latest revision. Cast iron tapping sleeves or stainless steel wrap-around sleeves, and cast iron valves shall be used to make live taps into the existing water mains where shown on the drawings. Flanges must conform to AWWA C207 Class D ANSI 150# drilling. Mechanical Joint (MJ) tapping sleeves are also acceptable. All bolts and nuts shall be stainless steel.
2. CONTRACTOR shall verify type of existing main prior to ordering. The tapping valve shall have an inlet flange to match the sleeve and a mechanical joint outlet for connection to water main pipe. Tapping valve shall meet the requirements for gate valves specified herein. The sleeve shall have provisions for a tap and shall be pressure tested at 150 psi for a minimum of 30 minutes prior to tapping.

G. Service Connection Materials

1. Service Saddles (see County Approved Product List, Appendix F)
 - a. Service saddles or fittings shall be used with taps to all types of pipe. Gasket shall be cemented in place and confined in a retaining groove. Saddles shall be cast iron saddles with double brass straps.
 - b. Tapping sleeves and valves shall be used for all taps.
2. Water Meters
 - a. Potable Water Meters: Potable water meters provided for service connections to the COUNTY water distribution system shall be designed to accept an encoder compatible with the COUNTY Automatic Meter Reading (AMR) system. The COUNTY will install the meter and the AMR encoder unit on 2" and smaller meters. AMRs 3" and larger shall be turned over to the technician doing the full bore flush. All potable water meters larger than 2" shall be installed above ground. These meters shall be equipped with a backflow preventer and installed by the CONTRACTOR at his expense, including the AMR encoder unit. The type of backflow device utilized for potable lines shall be on the Water Department approved list of backflow preventers, Appendix G. All potable water meters 3" or greater shall be purchased by the owner and installed by the CONTRACTOR. The master meter assemblies shall be built in accordance with the design details in Section 3 – Utilities Detail Drawings. The location of all meters shall be clearly shown on the construction plans.
 - b. Non-Potable Irrigation Water Meters: Non-potable water meters provided for service connections to the COUNTY non-potable reclaimed distribution system shall be designed to accept an encoder compatible with the COUNTY Automatic Meter Reading (AMR) system. The COUNTY will install the meter and the AMR encoder unit on 2" and smaller meters. All non-potable water meters 3" or greater shall be purchased by the owner and installed by the CONTRACTOR. The master meter assemblies shall be built in accordance with the design details in Section 3 – Utilities Detail Drawings. The location of all meters shall be clearly shown on the construction plans.
3. Corporation Stops for Service Connections
 - a. Corporation stops (see County Approved Product List, Appendix F) shall meet the requirements of AWWA C800; ends AWWA thread x compression, CTS.
4. Water Service Tubing

- a. Water service connection tubing shall be blue polyethylene municipal service tubing as shown on Utility Detail Drawing W-12.
 - b. Polyethylene tubing shall meet the requirements of AWWA Standard C901. Polyethylene tubing shall be 3406 polyethylene.
- 5. Polyethylene Service Tube Stiffeners
 - a. A solid ring, stainless steel insert shall be installed with each and every compression connection made with polyethylene tubing.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install all valves and appurtenances in accordance with manufacturer's instructions and in the locations shown, true to alignment and rigidly supported. Repair any damage to the above items to the satisfaction of the ENGINEER before they are installed.
- B. After installation, test all valves and appurtenances for at least one hour at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, repair it to the satisfaction of the ENGINEER.
- C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, check all plans and figures, which have a direct bearing on their location and assure the proper location of these valves and appurtenances during the construction of the structures.
- D. Flanged joints shall be made with stainless steel bolts.
- E. Buried mechanical joints shall be made with COR-TEN bolts.
- F. Prior to assembly of split couplings, thoroughly clean the grooves as well as other parts. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, center the gasket properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, tighten the nuts until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.
- G. Prior to the installation of sleeve-type couplings, thoroughly clean the pipe ends for a distance of 8". Soapy water may be used as a gasket lubricant. A follower

and gasket, in that order, shall be slipped over each pipe to a distance of about 6" from the end, and the middle ring shall be placed on the already laid pipe end until it is properly centered over the joint. Insert the other pipe end into the middle ring and bring to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flanges. After the bolts have been inserted and all nuts have been made up finger-tight, uniformly tighten diametrically opposite nuts progressively all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.

- H. Carefully inspect each valve, open it wide and then tightly close it and test the various nuts and bolts for tightness. Special care shall be taken to prevent any foreign matter from becoming lodged in the valve seat. Gate valves, unless shown otherwise, shall be set with their stems vertically above the centerline of the pipe. Remove and replace any valve that does not operate correctly.
- I. Carefully center valve boxes over the operating nuts of the valves so as to permit a valve wrench or key to be fitted easily to the operating nut. Valve boxes shall be set to conform to the level of the finished surface and held in position by a ring of concrete placed under the support flange as shown in Section 3, Utility Detail Drawings. The valve box shall not transmit surface loads to the pipe or valve. Exercise care to prevent earth and other material from entering the valve box. Any valve box which is out of alignment or whose top does not conform to the finished ground surface shall be dug and reset. Before final acceptance of the work, adjust all valve boxes to finish grade. Valve extension stems or risers shall not be used.

3.2 AIR RELEASE VALVE INSTALLATION

- A. Prior to pressure testing a pipeline, all air release valve assemblies on that pipeline shall be installed.

3.3 SHOP PAINTING

- A. Ferrous surfaces of valves and appurtenances shall receive a coating of epoxy in accordance with AWWA Standard C550 and meets or exceeds all test requirements including the Food and Drug Administration Document Title 21 of the Federal Regulations on Food Additives, Section 175.000 entitled "Resinous and Polymeric Coating"; Impact Test Requirement in accordance with the ASTM D2794.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 331619

HYDRANTS

PART 1 GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

- A. Furnish and install fire hydrants where shown on the Drawings or directed by the ENGINEER.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Section 033100 – Concrete for Non-Plant Work
- B. Section 331200 – Water Valves and Appurtenances

1.3 QUALITY ASSURANCE

- A. Install hydrants to meet current requirements of Collier County Utilities.
- B. Provide manufacturer's certificate those products meet or exceed minimum requirements as specified.

1.4 SUBMITTALS

- A. Submit manufacturer's certificates on conformance.
- B. Shop Drawings: Submit manufacturer's drawings and data sheets for material to be supplied under this Section. Indicate sizes and types to be installed.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. During loading, transportation and unloading, exercise care to prevent damage to materials.
- B. Handling: Fire hydrants should be unloaded carefully. The hydrant should be carefully lowered from the truck to the ground, not dropped. Only hoists and slings with adequate load capacity to handle the weight of the hydrant shall be used.
- C. Storage: Hydrants should be stored in the fully closed position to prevent entry of foreign material that could cause damage to the seating surfaces. Whenever practical, hydrants should be stored indoors. If outside storage is required, means should be provided to protect the operating mechanism. In outside storage, parts and flanges should be protected from the weather and foreign materials.

PART 2 PRODUCTS

2.1 FIRE HYDRANTS

- A. Fire hydrants shall be of the dry barrel, compression type conforming to AWWA C502 "Standard for Dry-Barrel Fire Hydrants" and additional requirements as set forth herein.
- B. Hydrant shall have break away upper sections capable of ready replacement without loss in the event of traffic damage. Each hydrant shall have a 6" bottom inlet connection and valve opening at least 5-1/4 inches in diameter. Hydrants shall have a national standard pentagon 1.5 inch, point to flat operating nut and turn to the left (counter clockwise) to open. Each hydrant shall be fitted with one 4-1/2-inch pumper connection and two 2-1/2 inch hose connections, both having threads that conform to the Fire Division Standard for the area. Hose caps shall be chained (unless specified without by appropriate fire control district) to the hydrant barrel and fitted with nuts similar to the hydrant operating nuts. Each hydrant shall have a barrel of sufficient length to bring the bottom of the 6" pipe connection 3 feet below the surface of the finished ground. Each hydrant shall have breakaway flanges and be made in at least two sections bolted together. All interior working parts of the hydrant shall be removable from the top of the hydrant to allow repairs without removing the hydrant barrel after it has been installed. Hydrants shall have renewable O-ring stem seals. Hydrant barrels shall be painted AWWA Safety Yellow (lead free) or as specified by appropriate fire control district. They shall be designed for a working pressure of 150 psi.
- C. Hydrant shall have no drain ports. If ports exist, they shall be plugged with a threaded plug.
- D. Operating stem shall be equipped with anti-friction thrust bearing to reduce operating torque and assure easy opening. Stops shall be provided to limit stem travel. Stem threads shall be enclosed in a permanently sealed lubricant reservoir with O-ring seals.
- E. Hydrants shall be designated for 150 psi working pressure and shop tested to 300 psi pressure with main valve both opened and closed. Under test the valve shall not leak, the automatic drain shall function and there shall be no leakage into the bonnet.
- F. Hydrants shall be of the years manufacture when construction commenced.
- G. Acceptable models, see Appendix F, County Approved Product List.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Set hydrants plumb and in true alignment with mains. Utilize restrained joints as shown in the Collier County Standard Details. Carefully backfill around hydrants so as not to disturb the hydrant and thoroughly compact backfill so as to support the hydrant securely. The hydrants shall have a minimum 18-inch clearance measured from finish grade to the center of pumper connection.
- B. Hydrants shall be located a minimum of 4 feet from the curb in urban areas, and a minimum of 14 feet from the edge of pavement in rural areas, and in accordance with local Fire Department requirements. A gate valve shall be provided at the connection to the main as shown in the Standard Details.
- C. Hydrants requiring a lead to cross a roadway shall have a valve on both sides of the road. The valve nearest the hydrant must be within 20 feet of the hydrant. This requirement is not applicable to privately owned and operated water distribution systems.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 333200

PUMP STATIONS

PART 1 GENERAL

1.1 SCOPE OF WORK FOR COUNTY PUMP STATIONS

- A. This section includes the following items for COUNTY owned and operated pump stations: wet wells, access covers, pumps, wet well equipment, valves, emergency bypasses, pump control panels, pump controller, antenna subsystem, disconnects, electric meters, electric service, pump wiring, lightning arrestors, and odor control systems.
- B. Conform all pump stations to the specifications, Utilities Detail Drawings, and latest National Electrical Code (NEC) requirements.
- C. When a pump station has a peak design flow coming into the station greater than 500 gpm, contact Public Utilities Planning and Project Management Department for specifications.
- D. For systems eligible to be taken over by the COUNTY, provide enough room to operate and maintain all water and wastewater systems in a simple and non-awkward manner. If a pump station pump needs to be replaced, provide enough room for the COUNTY to readily remove the pump, and to do so without interfering with traffic. To be eligible for conveyance to the COUNTY, the pump station easement area must be designed to 30'X30', or twice the depth of the wet well by twice the depth of the wet well, whichever is larger, as defined in the Collier County Standards and Procedures Ordinance, Subsection 7.7(c), as amended or superseded.
- E. Schedule required COUNTY inspections of (1) pump station installation prior to cover-up and (2) pump station start-up.
- F. Install all fencing and gates around the pump station in accordance with Section 323113.
- G. Communications: When proposing fiber-optic connectivity at pump stations, a letter of availability shall be requested to the COUNTY for review and approval.
- H. Elevated platforms shall be provided where necessary to provide access to wet wells, pump station control panels, electrical devices and panels, generators, and bypass equipment. Typically, these platforms shall be limited to locations with existing grades requiring equipment to be located at a higher elevation due to the Florida Building Code (FBC), FEMA, and the ASCE Standard 7 and 24 requirements.

1.2 SCOPE OF WORK FOR PRIVATE GRINDER PUMP STATIONS

- A. This section includes the following items for privately owned and operated grinder pump stations: wet wells, pumps, impeller, valves, level control, alarm, well equipment, pump control panels, pump controller, disconnects, and sloping requirements for private pump stations.
- B. All maintenance tasks for private grinder pump stations must be possible without entry into the grinder pump station per 29 CFR 1910.146 (OSHA Permit-Required Confined Spaces).
- C. The grinder pump station shall be free from electrical and fire hazards as required for functionality in a residential environment. The completed assembled and wired grinder pump station shall be listed by Underwriters Laboratories, Inc. (UL) to be safe and appropriate for the intended use. UL listing of components of the grinder pump station, or third-party testing to UL standard is not acceptable.
- D. All private grinder pump stations shall bear the seal of NSF International to show that station meets accepted standards for plumbing equipment in or near residences, shall be free from noise, odor, or health hazards, and shall have been tested by an independent laboratory to certify its capability to perform as specified in either individual or low-pressure sewer system applications.
- E. Private pump service sewers shall conform to applicable parts of the Florida Building Code and the COUNTY's Design Criteria. Where the COUNTY's standards are more restrictive than the Florida Building Code, the COUNTY's standards shall prevail.
- F. Private pump station force main connections must follow the COUNTY's requirements for testing.
- G. Schedule required COUNTY inspections of (1) testing of force main connection prior to cover-up and (2) pump station start-up.
- H. Prior to the start-up inspection, the following documentation must be furnished to the COUNTY via electronic mail or a secure electronic file transfer service:
 - 1. As-built drawing (in both PDF and DWG formats) showing the completed pump station and force main locations, sizes, materials, and elevations along with the location of all valves, the pump-out connection, the control panel, and the generator receptacle on the property and
 - 2. A pump test curve from the pump manufacturer.

PART 2 EQUIPMENT

2.1 MATERIALS FOR COUNTY PUMP STATIONS

- A. All stainless steel components and hardware shall be a minimum of Type 304, unless otherwise specified.
- B. Wet Well: The concrete structure shall consist of precast, reinforced sections conforming to ASTM C76 and/or ASTM C478. 8-foot diameter wet wells shall have a minimum wall thickness of 8 inches. Wall thickness for larger wet wells shall conform to ASTM standards for wall thickness, but shall not be less than 8 inches in any case. The minimum inside diameter for all wet wells eligible to be owned and maintained by Collier County shall be 8 feet. As a deviation, a 6-foot

diameter wet well can be utilized if the ENGINEER can demonstrate that the wet well is sufficient hydraulically and the developer can demonstrate that the pump station shall be used for the perpetual and exclusive use of that development. For pump stations that will not be owned and maintained by Collier County, the ENGINEER shall set the design specifications for the wet well, provided such design does not in any way endanger the health, safety and/or welfare of the public. Base riser section shall be monolithically cast with the base slab. All concrete shall utilize Type 2 cement and have a minimum compressive strength of 4000 psi at 28 days. On new construction, if more than one hole is abandoned and required to be cemented in, provide a new wet well barrel section. Reinforcing steel for all wet well structures should be sized by the unit manufacturer and verified by the ENGINEER. All connections to the wet well for gravity sewer piping shall be equal to those for manholes as described in Section 333913. Factory double coat all exterior surfaces with an acceptable bituminous or epoxy sealer a minimum of 18 mils thick. Seal all riser joints utilizing plastic joint sealing compound (see County Approved Product List, Appendix F). Reinforcement and top slab thickness shall be specified by the design ENGINEER for H-20 loadings in all cases. Minimum reinforced slab thickness shall be 8 inches. Typical standards for wet wells are available in the Collier County Standard Details. The ENGINEER shall be responsible for designing all wet well structures to overcome buoyancy forces exerted on the installed structure. Coat all wet well interiors with an acceptable field applied internal protection (see County Approved Product List, Appendix F) in accordance with Section 099723.

- C. Above-Ground Valves and Piping: Above-ground valves and piping must be positioned so that it does not lie above any gravity sewer line entering the wet well, unless field conditions dictate otherwise and the COUNTY has granted prior approval. Typical above-ground valves and piping standards are shown in the Collier County Standard Details. All valve and flange bolting shall be Type 316 stainless steel.
- D. Pumps: Sewage pumps (see County Approved Product List, Appendix F) shall be of the submersible type suitable for operation in sewage of temperature not exceeding 115 degrees Fahrenheit. Pump head curves and design specifications for each application proposed shall be submitted for review and approval within the ENGINEER's hydraulic design report. All pumps shall be three-phase unless approved by a Utility Deviation Form. At least one (1) pump in each wet well shall be equipped with an opening in the volute with a bolted cover for a mix-flush system (see County Approved Product List, Appendix F).
- E. Access Covers: Access covers for pump station wet wells shall be above the 100-year flood elevation unless the structure is located within a documented velocity and tidal flood zone, and elevation differentials prohibit such installation. In such cases, watertight access covers shall be utilized. The ENGINEER shall provide shop drawings of such access covers for review and approval by THE County Manager or designee prior to use. Access covers shall be constructed of diamond plate aluminum sheets and aluminum structural members. All access covers shall be attached to aluminum angle frames with stainless steel hinges and fasteners. Angle frames shall be firmly anchored into the top concrete slab of the structure.

All access covers shall be equipped with a ratchet-type restraint mechanism to prevent accidental closing of the cover and torsion bar or spring assist type openers. Assist openers shall be manufactured of stainless steel. Access covers shall be designed for H-20 loadings.

- F. Wet Well Equipment: All pump discharge piping shall be HDPE pipe and shall be in conformance with pipe utilized for wastewater force mains. All fittings shall be HDPE fused, flange/flange, or Uni-Flange connections. All nuts, bolts, fasteners, brackets, pump guide rails and other hardware located inside the wet well shall be 316 stainless steel. A pump out with a screened vent shall be provided on all installations, with the pipe extended through the wet well lid (see details). Electrical systems and components (e.g. motors, lights, cables, conduits, switch boxes, control circuits, etc.) in raw wastewater wetwells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present shall comply with the National Electrical Code (NEC) requirements for Class I Group D, Division 1 locations. Electrical equipment located in wet wells shall be suitable for use under corrosive conditions.
- G. Valves: Discharge piping for each pump shall be equipped with a weighted check valve and plug valve. A tee with an isolation plug valve, equipped with a quick coupling (see County Approved Product List, Appendix F), shall be provided for a means of emergency bypass access to the wastewater force main. Valves shall be supported by stainless steel pipe supports.
- H. Emergency Bypass: A 4-inch emergency bypass connection shall be provided down-stream from the in-line discharge piping valves. The connection shall be readily accessible and be equipped with a plug-type isolation valve and 4-inch male camlock type quick coupling and cap.
- I. Pump Control Panel (see County Approved Product List, Appendix F): Panel enclosure construction shall be equal to a NEMA 4X stainless steel with 3-point latch where required and utilize stainless steel. When possible, panel door shall open away from wetwell and not towards wetwell hatch to ensure safety during maintenance of wetwell and panel. To ensure proper installation of control panel, contact the Wastewater Division prior to rough-in or installation of control panel, for a pre-construction meeting with respective Wastewater Collections personnel. Control panels shall be mounted on two 6-inch by 6-inch precast concrete posts. All mounting bars, nuts, bolts, etc. shall be stainless steel. A 110/120-volt (110V) receptacle shall be provided inside the control panel for pump stations that have outdoor control panels. Ground fault interruption (GFI) protection shall be provided for all outdoor outlets.
- J. Pump Controller: Provide a pump control panel (see County Approved Product List, Appendix F) including a telemetry control unit (TCU) for pump controlling purposes. At a minimum, the TCU shall include an integrated 2-Watt digital radio with an Ethernet module for dual communications capability, an 18-amp-hour back-up battery, a manufacturer's prefabricated wire harness, all manufacturer recommended surge protection, and suitable devices for measuring wastewater flow. The TCU shall incorporate three on-board fail-safe HOA switches and

Triplex/Duplex/Simplex configurable operation mode. An on-board 240 or 460 VAC three-phase monitor shall be provided. The Alarm light and bell shall be activated by the TCU and the external push-button alarm silence switch shall be wired into the TCU. The TCU shall incorporate an on-board 4- by 20- character LCD display for elapsed runtime of each pump. During the automatic sequence, the pumps shall be controlled in an alternate mode. Pump controller shall be Data Flow Systems model TCU800 with features listed above.

- K. Antenna Subsystem: Provide a high gain antenna (see County Approved Product List, Appendix F) for use to transmit and receive TCU data to and from the COUNTY's existing SCADA server. Antenna shall utilize all welded-aluminum elements. Element connections utilizing nuts and bolts are not acceptable. Antenna shall have a single radiator element connected to a type N female connector. Antenna shall be supported on a mast/pole and have DC grounding for lightning protection. Antenna mounting hardware shall be made of stainless steel. Antenna shall meet or exceed the quality, reliability and performance of the RTA series as provided by Data Flow Systems, Inc. Antenna mast/pole shall be a 21foot by 1.25 inch SCH80 galvanized pole. Mounting of the antenna mast/pole shall be in accordance with all applicable local and state building codes as they pertain to structural strength and wind velocity requirements. Tower shall meet or exceed the quality and reliability of the 25G manufactured by Rohn. Coaxial cable shall be RTC 400 as supplied by Data Flow Systems, Inc. Type N connectors shall be utilized at both ends of the coax. Type N connectors shall be sealed with 3-inch sections of Alpha FIT321-1-0 sealant shrink tubing. Coaxial cable shall be secured to the mast/pole with E.V.A.-coated 316 stainless steel cable ties. Cable ties shall meet or exceed the quality, reliability and performance of AE112 cable ties manufactured by Band-It. For pump stations to be conveyed to the County, a startup and successful testing of Data Flow telemetry equipment by Data Flow representatives and County Wastewater Collections instrumentation and telemetry representatives is required prior to County acceptance. After initial startup, for pump stations to be conveyed to the County, the latitude and longitude of pump stations shall be provided.
- L. Disconnect: A circuit breaker disconnect shall be provided to isolate the pump control panel. Disconnect shall be installed on the service line between the electric meter and control panel and shall be lockable in the "ON" or "OFF" position. Disconnects shall be housed in a NEMA 4X, stainless steel enclosure or better.
- M. Electric Meter: The electric meter servicing the pump station shall be located adjacent to the pump control panel, and shall be located and wired to service only the pump station facility.
- N. Electric Service: All underground electric services shall be fully conduited in 2-inch diameter Schedule 80 PVC pipe from the power company source point to the pump control panel. The maximum length of the electric service from the power company transformer to the pump control panel shall be 200 feet. One spare conduit shall be provided and terminated in the meter. Only copper service wire shall be utilized. Sizing of the service wire shall be verified with the power company and the

extent and location of the service shall be indicated on the record drawings. The CONTRACTOR shall certify that the voltage drop across the service does not exceed five percent (5%) of the power company's line voltage at full load start-up of the pump station pumps. All pump stations shall have minimum 100-amp service. All electrical components shall be located within the COUNTY right-of-way or County Utility Easement (CUE).

- O. Pump Wiring: Power wiring for each pump, from the control panel to the wet well shall be conduited in separate 2-inch diameter Schedule 80 PVC pipe and an appropriately sized water-tight fitting with separate strain relief shall be installed on each line. A spare parallel 2-inch PVC pipe conduit from the panel to the wet well shall be provided. All wire shall be stranded THHN or MTW copper wire. The pump motor cords shall be flexible and serviceable under conditions of extreme usage. Total of angle bends shall be 180 degrees or less. All conduits between wetwell and control panel shall not exceed a total of 180 degrees of bends per run. All service conduits shall be 2" Schedule 80 PVC except where noted. The pump motor cords shall be flexible and have an appropriate amount of slack.
- P. Lightning Arrestors: All pump stations shall be equipped with lightning arrestor(s) (see County Approved Product List, Appendix F). The lightning arrestor shall be installed externally on the load side of the disconnect, between the disconnect and the main breaker. The penetration through the disconnect must be made below the working mechanism of the disconnect.
- Q. Odor Control Systems for Community Pump Stations: Furnish and install an 8'X11' concrete slab for potential future odor control system. A Pre-Engineered Biofiltration Odor Control System shall be furnished if required by the engineer of record.
- R. Platforms and stairs shall meet the Occupational Safety and Health Administration (OSHA) Part 1910, applicable FBC requirements, and ASCE Standards 7 and 24. All platform and stair designs and plans shall be prepared by a Florida Registered Professional Engineer. The Engineer of Record shall identify Flood Hazard Area, Flood Design Class (ASCE 24) and other applicable loadings. All components shall be aluminum with stainless steel hardware. Standard stairs shall be utilized. Fall protection shall be provided on all exposed sides by use of an OSHA approved guardrail system. Where required for access, removable guardrail sections shall be provided. Grating shall be slip resistant and banded at ends of bearing bars and openings.
- S. All platforms and stairs shall be supported by a concrete foundation system. The foundation designs and plans shall be prepared by a Florida Registered Professional Engineer. It shall meet the requirements of the FBC, ASCE 7 (Dead, Live, Flood, and Wind), ASCE 24 (Flood Resistant) and other regulatory requirements. Where head clearance under the platform is less than 6'-8", provisions shall be made to limit access.

2.2 MATERIALS FOR PRIVATE PUMP STATIONS

- A. All private grinder pump stations shall conform to the requirements specified in Section 2.1 above, unless otherwise stated in this section.
- B. Pumps: Private pump stations shall be constructed using progressive cavity, non-clogging, non-jamming, positive or semi-positive displacement grinder pump(s) capable of operating at a negative total dynamic head (TDH) equipped with thermal overload protection. Grinder pumps shall be capable of grinding all material typically found in domestic or commercial wastewater to a fine slurry that will pass through the pump, 1-1/4-inch NPT discharge piping and downstream appurtenances.
- C. Impeller: The grinder impeller shall be a one-piece, rotating type cutter wheel constructed from hardened 4140 steel. The cutter teeth shall be treated and hardened to 56 to 60 Rockwell C. The shredder ring shall be stationary type with a staggered tooth pattern and made of white cast iron per ASTM A532(1B).
- D. Valves: In addition to valve requirements described in Section 2.1, an anti-siphon valve shall be integral with the grinder pump station pump. The anti-siphon port diameter shall be no less than 60% of the inside diameter of the grinder pump station discharge piping. The check valve will provide a full-ported passageway when open and shall introduce a friction loss of less than 6 inches of water at maximum rated flow.
- E. Level Control: Level sensing control for private grinder pump stations shall be a non-fouling type with no moving parts in contact with the wastewater.
- F. Alarms: All grinder pump station shall be equipped with a high level audible and visual warning alarm to notify the residential or commercial property owner(s) of a high wet well level.
- G. Wet Well: The wet-well basin for all grinder pump stations shall be constructed from any watertight material suitable for light commercial applications, such as high-density polyethylene (HDPE), polyethylene (PE), or glass-fiber reinforced polyester (FRP). FRP wet wells must conform to ASTM D3753. All grinder pump station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure. The grinder pump station shall have all necessary penetrations molded in and factory sealed. To ensure a leak free installation, no field penetrations will be acceptable. No secondary welding of the wet well basin or cover will be accepted. The wet well shall be vented to the atmosphere.
- H. Wet Well Equipment: Pumps and all electrical devices, components, and connections inside the wet well shall be explosion proof.
- I. Anti-Siphon/Check Valve: All private grinder pump stations shall be equipped with a factory installed, gravity operated flapper-type integral check valve and anti-siphon valve built into the stainless-steel discharge piping, per Section 2.1 and Section 2.2. valve requirements.
- J. Pump Control Panel: All electrical elements for private grinder pump stations shall be furnished pre-wired and housed in a NEMA 4X enclosure. In a flood zone, a NEMA 6P

enclosure is required if the control panel is mounted less than a foot above the base flood elevation. A NEMA Control circuit shall be 115 volts. The door of the control box shall be hinged of the dead type with locking hasp and suitable accessories to allow wall mounting. Motor shall be activated by a magnetic type contactor and protected by a UL-listed electrical monitoring system against damaging high current or low voltage conditions. An automatic reset, integral thermal overload protector shall protect the motor against excessive heat. The sensor shall reset automatically when the motor cools. An alarm test switch, HOA switch, run light, auto/off switch, and overload reset button shall be supplied inside the control box. A terminal strip with box type connections shall be supplied to make all power and control connections. All terminals shall be marked for easy identification. A ground terminal strip shall also be provided and labeled.

- K. Disconnect: The grinder pump station shall be equipped with a factory-installed NEMA 6P electrical quick disconnect for all power and control functions.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Finished grade shall be 1 inch to 4 inches below the bottom of the lid and shall slope away from the wet well.
- B. Fill grinder pump stations with water prior to backfill compaction to prevent deformation of the basin wall and follow all other manufacturer's installation instructions.

END OF SECTION

NO TEXT FOR THIS PAGE

SECTION 333313

WASTEWATER VALVES AND APPURTENANCES

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.
- B. The equipment shall include, but not be limited to, the following:
 - 1. Eccentric Plug Valves
 - 2. Check Valves
 - 3. Vacuum Breakers
 - 4. Air Release Valves
 - 5. Flange Adapter Couplings
 - 6. Flexible Couplings
 - 7. Diaphragm Seals
 - 8. Unions
 - 9. Mechanical Type Seals
 - 10. Hose End Faucets
 - 11. Pressure Gauges
 - 12. Reduced Pressure Backflow Preventer
 - 13. Flow Meters

1.2 DESCRIPTION OF SYSTEMS

- A. All the equipment and materials specified herein are intended to be standard for use in controlling the flow of wastewater and reclaimed water.

1.3 QUALIFICATIONS

- A. All the types of valves and appurtenances shall be products of well-established reputable firms who are fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these specifications as applicable.

1.4 SUBMITTALS

- A. Submit within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.
- B. Complete shop drawings of all valves and appurtenances shall be submitted to the ENGINEER for approval in accordance with the General Conditions.

1.5 TOOLS

- A. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 PRODUCTS

2.1 GENERAL

- A. All valves and appurtenances shall be of the size shown on the Drawings and as far as possible all equipment of the same type shall be from one manufacturer.
- B. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
- C. All stainless steel components and hardware shall be a minimum of Type 304, unless otherwise specified.

2.2 DESIGN

- A. Eccentric Plug Valves
 - 1. All valves (see County Approved Product List, Appendix F) shall be eccentric plug valves unless otherwise specified.
 - 2. Plug valves shall be tested in accordance with AWWA C504 Section 5. Each valve shall be performance tested in accordance with AWWA C504 Section 5.2 and shall be given a leakage test and hydrostatic test as described in AWWA C504 Paragraphs 5.3 and 5.4. The leakage test shall be applied to the face of the plug tending to unseat the valve. The Manufacturer shall furnish certified

copies of reports covering proof of design testing as described in AWWA C504 Section 5.5.

3. Plug valves shall be of the tight closing, resilient faced, non-lubricating variety and shall be of eccentric design such that the valve's pressure member (plug) rises off the body seat contact area immediately upon shaft rotation during the opening movement. Valve pressure ratings shall be as follows and shall be established by hydrostatic tests as specified by ANSI B16.1-1967. Valves shall be drip-tight in both directions (bi-directional) at rated pressure of 175 psi through 12-inch diameter, and 150 psi for 14-inch diameter and above. The valve shall be provided with a 2-inch square operating nut.
4. The valve body shall be constructed of cast iron ASTM A126, Class B. Body ends shall be mechanical joint to meet the requirements of AWWA C111/ANSI A21.11 or single gasket push-on type.
5. The valve plug shall be constructed of cast iron or ductile iron and shall have a conical seating surface that is eccentrically offset from the center of the plug shafts. The plug and shafts shall be integral. The entire plug face shall be totally encapsulated with Buna N (Nitrile) rubber in all valve sizes. The rubber to metal bond must withstand 75 lbs. pull under test procedure ASTM D-429-73, Method B. When the plug is in full open position, plug geometry and body waterway contours must provide a passageway that allows flow capacity equal to 100% of the adjacent pipe area.
6. Valve seat mating surface shall be constructed of a welded-in overlay of not less than 90% nickel or be a one-piece stainless steel ring. Seat ring contour must be precision machined.
7. A mechanical "brake" shall be supplied on all valves and shall be capable of "locking" the valve in any intermediate position between full-open and full-closed.
8. Valves shall have multiple V-type packing and packing glands and shall be capable of being field adjusted or repacked without the bonnet or plug being removed from the valve with the valve under the full rated pressure. Valves shall have a port position indicator.
9. For corrosion protection, the interior ferrous surfaces of all plug valves shall have a 2-part epoxy internal coating to a minimum of 20 mils thickness.
10. Valve shaft seals shall be adjustable and comply with AWWA C507 Section 10 and with AWWA C507 Section 11.
11. Manual valves shall have lever or gear actuators and tee wrenches, extension stems, floorstands, etc. as indicated on the plans. All valves 6" and larger shall be equipped with gear actuators. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all

shafts to prevent entry of dirt and water into the actuator. All actuator shafts shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. All adjustable stop shall be provided to set closing torque. All exposed nuts, bolts, and washers shall be stainless steel. Valve packing adjustment shall be accessible without disassembly of the actuator.

12. Valves and gear actuators for submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washers shall be stainless steel.
13. Three-way plug valves shall be non-lubricated gear oriented. Valve bodies shall be ASTM A-126 Class, and be semi-steel with 125 lb. ANSI standard flanges. Plugs shall be resilient faced. Three-way valves shall be 3-way, 3-port 270-degree turn.
14. Plug valves installed such that actuators are 6 feet or more above the floor shall have chain wheels.
15. Where shown on the Drawings, plug valves shall be installed with extended shafts and actuators. Actuators for extended shafts shall be mounted on floor stands where indicated on the drawings or shall be removable handwheels where floor stands are not called for. Six-inch sleeves shall be provided for extended shafts in all floors; where necessary covers shall be provided. Shafts shall be of adequate strength to operate the valve and shall be stainless steel where submerged and carbon steel elsewhere. Floor stands and covers, where called for shall be cast iron. Floor stands shall be equipped with valve position indicators. Where shown on the drawings, plug valves shall be furnished with extended bonnets, equal to DeZurik Figure 640.
16. All buried plug valves shall have a remote position indicator in the valve box showing position of the valve. A stainless steel centering and I.D. plate shall be provided showing direction of opening and number of turns to open for each valve.

B. Valves for Buried Service

1. Valves for buried service shall meet all the requirements as specified herein for interior except that buried valves shall have mechanical joint ends.
2. All buried valves shall have cast-iron two-piece valve boxes (see County Approved Product List, Appendix F), valve boxes shall be provided with suitable heavy bonnets to extend to such elevation at the finished grade surface as directed by the ENGINEER. The barrel shall be two-piece, screw type. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling, shall be designed to prevent the transmission of surface loads

directly to the valve or piping, and shall be complete with cast iron covers. Covers shall have "SEWER" cast into the top. The covers shall be so constructed as to prevent tipping or rattling. All valve boxes located in paved roadways or sidewalks shall have locking covers.

3. Where valves are located out of pavement, the boxes shall be adjusted to finished grade and a concrete slab two feet square and six inches thick shall be poured around the box, as shown in the Details.
4. Valve boxes shall be of the heavy duty, traffic bearing cast iron, adjustable screw type with a drop cover. The valve box assembly shall consist of a bottom section, top section and cover which is cast from gray iron, formulated to ASTM specification A-48 latest revision, minimum tensile of 21,000 psi and shall be free from blowholes, shrinkage or other imperfections not true to pattern. The shaft size shall be 5 1/4" and the adjustable length shall be from 18" to 36". The wall thickness shall be 1/4". The weight of the assembly shall be 61 pounds $\pm$ 2 pounds, with the cover weight being a minimum of 13 pounds.
5. The name of the manufacturer and foundry of origin shall be cast into each of the components of the assembly in legible form. The assembly shall be suitable for highway traffic wheel loads of 16,000 pounds and shall withstand a proof load test of 25,000 pounds without failure or permanent deflection. The valve box shall be cast, machined, assembled, and packaged within the United States and shall fully comply with the Buy American provisions of Public Law 102-240, enacted 12/18/91.

C. Check Valves

1. All check valve bodies shall be cast iron per ASTM A126 Class B, having integral (not Wafer) flanges.
2. The seat shall be centrifugally cast bronze with an O-ring seal and be locked in place with stainless steel lock screws and be field replaceable, without the use of special tools.
3. The shaft shall be single and continuous stainless steel, extending on one side of the body with a lever and weight.
4. The air cushion cylinder, when specifically required, shall be constructed of corrosion-resistant material and the piston shall be totally enclosed within the cylinder and not open at one end. The air cushion cylinder assembly shall be externally attached to either or both sides of the valve body and will permit adjustability to cushion the closure of the valve. Cushioning shall be by air trapped in the cushion cylinder, which shall be fitted with a one-way adjustable control check valve to cushion disc contact to the seat at the shut-off point. The bottom cylinder head shall be swivel mounted and not rigid to follow the change of force angles as the lever raises or lowers to open or close the check valve.

Valve shall prevent backflow on normal pump shut-off or power failure, at zero velocity, and be watertight.

5. The disc shall be cast iron utilizing a double clevice hinge connected to a ductile iron disc arm. The disc arm assembly shall be suspended from a stainless steel shaft, which passes through a seal retainer on both sides of the valve body.
6. Valve exterior to be painted with Red Oxide Phenolic Primer Paint as accepted by the FDA for use in contact with Potable Water. Materials shall be certified to the following ASTM specifications:
 - a. Body, cover & disc - Cast Iron - ASTM A126, Class B
 - b. Disc Arm - Ductile Iron - ASTM A536
 - c. Seat - Aluminum Bronze or Stainless Steel - ASTM B148, ASTM A276
 - d. Disc Seat - Buna-N or metal
 - e. Cushion cylinder - Corrosion-resistant Commercial material
 - f. Exposed Nuts and Bolts – 316 Stainless Steel
7. For corrosion protection, the interior ferrous surfaces of all check valves used in sewage applications shall be coated with a factory applied, two-part epoxy coating to a minimum of 20 mils thick.

D. Automatic Air Release Valves for Wastewater Systems

All force mains shall have automatic air release valves installed as they are indicated on the plans. These Automatic Air Release Valves (ARV's) shall conform to the following:

1. The ARV shall be a "Combination" ARV modified with a check valve on the discharge of the air piping to allow air release only operation.
2. The body of these valves shall be conical shaped to maintain maximum air gap to ensure no contact between the sewage and the seal.
3. The ARV shall seal at zero (0) psi and have an overall operating range of 0 – 250 psi, (0 – 17.2 bar).
4. The ARV shall close watertight when liquid enters the valve, even when the fluid is rising without pressure, (no minimum operating pressure required).
5. The working pressure shall be 250 psi (17.2 bar) tested to 360 psi (25 bar).

6. The ARV shall include both a Polypropylene Debris Shield funnel and an Orifice Strainer to prevent solids from entering sealing area.
7. The ARV shall have a rolling cup seal diaphragm for infinitely variable operation, providing water hammer inhibition.
8. The ARV body shall be constructed of 316 stainless steel. The float shall be Delrin (Polyoximethylene, POM) and the Float Spindle shall be of 316 stainless steel. The valve seat and all internal working parts shall be of corrosion-resistant materials. ARV flange hardware (nuts, bolts, washers) shall be of 316 stainless steel construction.
9. The threaded or flanged outlet size of the ARVs shall be sized by the design engineer. A minimum diameter of two inches (2") shall be provided.
10. All parts required for ARV maintenance shall be the same for all connection sizes (i.e. the internal parts for the 2" ARV are identical to the internal parts for the 4" ARV).
11. All ARV manufacturers and models shall comply with the County Approved Product List (Appendix F). All ARVs shall be installed in accordance with manufacturer recommendations and shall have an isolation valve connection for control.
12. All ARVs installed for wastewater transmission systems (except at pump stations or wastewater treatment facilities) shall be installed in above ground polyethylene enclosures as shown on the County's standard details. Color of enclosures shall be dark green.

E. Flange Adapter Couplings

1. Flange adapter couplings shall be of the size and pressure rating required for each installation and shall be suitable for use on either cast iron or ductile iron pipe. They shall be similar or equal to Dresser Company, Style 128. All couplings shall have enough factory installed anchor studs to meet or exceed the test pressure rating for this project, 100-psi minimum.

F. Flexible Couplings:

1. Flexible couplings shall be either the split type or the sleeve type as shown on the Drawings.
 - a. Split type coupling shall be either the split type or the sleeve type as shown on the Drawings. The couplings shall be mechanical type for radius groove piping. The couplings shall mechanically engage and lock grooved pipe ends in a positive coupling and allow for angular deflection and contraction and expansion.

- b. Couplings shall consist of malleable iron, ASTM Specification A47, Grade 32510 housing clamps in two or more parts, a single chlorinated butyl composition sealing gasket with a "C" shaped cross-section and internal sealing lips projecting diagonally inward, and two or more oval track head type bolts with hexagonal heavy nuts conforming to ASTM Specification A183 and A194 to assemble the housing clamps. Bolts and nuts shall be stainless steel.
- c. Victaulic type couplings and fittings may be used in lieu of flanged joints. Pipes shall be radius grooved as specified for use with the Victaulic couplings. Flanged adapter connections (see County Approved Product List, Appendix F) at fittings, valves, and equipment.
- d. Sleeve type couplings (see County Approved Product List, Appendix F) shall be used with all buried piping. The couplings shall be of steel. The coupling shall be provided with stainless steel bolts and nuts unless indicated otherwise.
- e. All couplings shall be furnished with the pipe stop removed.
- f. Couplings shall be provided with gaskets of a composition suitable for exposure to the liquid within the pipe.
- g. If the CONTRACTOR decides to use victaulic couplings in lieu of flanged joints, he shall be responsible for supplying supports for the joints.

G. Diaphragm Seals (see County Approved Product List, Appendix F):

- 1. Diaphragm seals shall be installed on pressure gauge connection to all lines where shown on the Drawings, to protect pressure switches used to monitor excessive pressures on pipe lines. The diaphragm shall be "thread attached" to both piping and pressure switches. Diaphragm seals shall be constructed of cadmium plated carbon steel, except for the lower housing which shall be specifically chosen according to the fluid pressure being monitored.
- 2. Diaphragm seals shall have a flushing connection.

H. Unions

- 1. Unions on ferrous pipe 2" in diameter and smaller shall be 150 pounds malleable iron, zinc-coated. Unions on water piping 22" in diameter and larger shall be flange pattern, 125-pound class, zinc-coated. Gaskets for flanged unions shall be of the best quality fiber, plastic, or leather. Unions shall not be concealed in walls, ceilings, or partitions.

I. Mechanical Type Seals

1. Mechanical type seals (see County Approved Product List, Appendix F) shall consist of an adjustable modular bolted, synthetic rubber and plastic sealing element.

J. Hose End Faucets

1. Hose end faucets (see County Approved Product List, Appendix F) for potable water supply at submersible stations shall be furnished with removable key and shall be lockable.

K. Pressure Gauges

1. Each pressure gauge shall be direct mounted, cast aluminum case, with a four inch (4") diameter dial and furnished with a clear glass crystal window, 3/8" shut-off valve, and a bronze pressure snubber. Provide diaphragm seals between shut-off valve and pressure gauge on all sludge and lines with nonclear matter in suspension of solution. All gauges shall be weatherproofed. The face dial shall be white finished aluminum with jet black graduations and figures. The face dial shall indicate the units of pressure being measured (e.g., feet, inches, etc.) or be dual scale.
2. Gauges shall be sized with an appropriate range of pressure readings shown in pounds per square inch (PSI).

L. Reduce Pressure Backflow Preventer

1. If shown on the drawings, backflow preventers shall be supplied at each pump station, and installed in accordance with the Collier County Standard Details.

M. Flow Meters for Master Pumping Stations

1. Meters shall be of the magnetic type (see County Approved Product List, Appendix F). Flow meters shall be designed to record both the peak pumping station capacity and anticipated minimum flows with equally high accuracy. All meters shall be tied to the Radio Telemetry SCADA System. The flow metering system shall be installed within the pumping station structure, if space is available, or in an exterior protected and drained pit. In all cases, meter bypass valves and piping shall be provided.
2. Flow meters shall be supplied for "Master Pumping Stations" only.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install all valves and appurtenances in the locations shown, true to alignment and rigidly supported. Repair any damage to the above items to the satisfaction of the ENGINEER before they are installed.
- B. Carefully inspect each valve, open it wide and then tightly close it, and test the various nuts and bolts for tightness. Take special care to prevent any foreign matter from becoming lodged in the valve seat. Valves, unless shown otherwise shall be set with their operator shaft vertically. Repair and replace any valve that does not operate correctly.
- C. Carefully center valve boxes over the operating nuts of the valves to permit a valve wrench or key to be fitted easily to the operating nut. Valve boxes shall be set to conform to the level of the finished surface and held in position by a ring of concrete placed under the support flange as shown on the Collier County Standard Details. The valve box shall not transmit surface loads to the pipe or valve. Care shall be taken to prevent earth and other material from entering the valve box. Any valve box which is out of alignment or whose top does not conform to the finished ground surface shall be dug out and reset. Before final acceptance of the work, adjust all valve boxes to finish grade. Valve operating risers shall be installed with any valves required to ensure that the operating nut is 30-inches or less from the ground surface.
- D. After installation, test all valves and appurtenances for at least 1 hour at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, repair it to the satisfaction of the ENGINEER.
- E. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, check all plans and figures that have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.
- F. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections.
- G. Buried mechanical joints shall be made with COR-TEN bolts.
- H. Prior to assembly of split couplings, thoroughly clean the grooves as well as other parts. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, center the gasket properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, tighten

the nuts until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.

- I. Prior to the installation of sleeve-type couplings, thoroughly clean the pipe ends for 8 inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to about 6" from the end, and the middle ring shall be placed on the already laid pipe end until it is properly centered over the joint. Insert the other pipe end into the middle ring and bring to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flaires. After the bolts have been inserted and all nuts have been made up finger-tight, uniformly tighten diametrically opposite nuts progressively all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.

3.2 AIR RELEASE VALVE INSTALLATION

- A. Each air release valve shall be installed at a high point in the pipeline.
- B. Prior to pressure testing a pipeline, all air release valve assemblies on that pipeline shall be installed.

3.3 SEWER SERVICE CONNECTIONS

- A. Materials, Construction:
 1. All sewer service connections shall be of SDR 35 PVC as specified herein with elastomeric gaskets on pipe and fittings.
 2. Service lines shall be connected to the sewer mains by means of a PVC wye fitting. The service branch of the wye fitting will be elevated depending on the depth of the sewer and the elevation of the property to be served. 45-degree bends or other fittings shall be used to connect the service line at the wye branch. Service lines shall be installed at such grades as will adequately serve the properties, minimum 1% slope.
 3. Service lines shall extend from the sewer to the property line and be plugged. Plugs shall be plastic with sealer. Service lines shall be 6 inches for single residential properties and 6 inches pipe and larger for commercial, industrial, and multiple residential services. Service lines will have a minimum of 3 feet and a maximum of 5 feet of cover at the property line. Service will be provided to each lot. All laterals shall have a vertical clean out installed at the property line. Clean outs shall extend 24 inches above grade and should be capped. After final connection of the lateral to a structure the clean out shall be cut off at grade and capped.

3.4 SHOP PAINTING

- A. Coat ferrous surfaces of valves and appurtenances with rust-inhibitive primer. Cap all pipe connection openings to prevent the entry of foreign matter prior to installation.

3.5 FIELD PAINTING

- A. Paint all metal valves and appurtenances specified herein and installed in valve and meter pits as specified.

3.6 INSPECTION AND TESTING

- A. Subject completed pipe to hydrostatic pressure test at full working pressure. Repair all leaks and retest the line as approved by the ENGINEER. Prior to testing, support the gravity pipelines in an approved manner to prevent movement during tests.

END OF SECTION

SECTION 333913
SEWER MANHOLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for providing sewer manholes and all other appurtenances for a complete installation. Provide precast reinforced concrete manholes conforming to ASTM C478 in accordance with the Collier County Standard Details.
- B. Related Work Specified in Other Sections Include:
 - 1. Section 055600 – Metal Castings
 - 2. Section 099723 – Concrete Coatings

1.2 REFERENCE

- A. Codes and standards referred to in this Section are:
 - 1. ASTM C 76 - Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
 - 2. ASTM C 478 - Specification for Precast Reinforced Concrete Manhole Sections
 - 3. ASTM C 32 - Specification for Sewer and Manhole Brick (Made for Clay or Shale)
 - 4. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets [Metric]

1.3 SUBMITTALS

- A. Shop Drawings: Submit shop drawings of sewer manholes as specified in Division 1.
- B. Quality Control: Submit shop and field test reports of concrete samples tested in an approved laboratory.

1.4 DELIVERY, STORAGE AND HANDLING

- A. General: Take every precaution to prevent injury to the manhole sections during transportation and unloading. Unload manhole sections using skids, pipe hooks, rope slings, or suitable power equipment, if necessary, and keep the sections under control at all times. Do not allow the manhole sections to be dropped, dumped or dragged under any conditions. Follow applicable requirements specified in Division 1.
- B. Damaged Section: If any manhole section is damaged in the process of transportation or handling (see Section 2.3.C below), contact the Public Utilities Wastewater Department for visual inspection. If the Wastewater Department deems it necessary to reject the manhole section, reject and immediately remove such sections from the site, and replace the damaged manhole sections at no increase in Contract Amount.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. See County Approved Product List, Appendix F, for acceptable manufacturers of plastic joint sealing compound and sewer manhole frames and covers.

2.2 MATERIALS

- A. Concrete, Steel Reinforcement and Aggregates: Provide reinforced concrete, cementitious materials, aggregates and steel reinforcement conforming to the requirements of ASTM C 478, with 4000 psi concrete, Grade 40 reinforcement bars, Type II cement, and a minimum wall thickness of 8 inches.
- B. Steel reinforced polymer concrete manholes may be furnished and installed instead of the Type II cement manholes described above. If provided, steel reinforced polymer concrete manholes shall not require interior and exterior protection as described in part 3.1 F and 3.1 G. All steel reinforced polymer concrete structures shall be supplied by a qualified company with a minimum of 5 years' experience manufacturing polymer concrete. All steel reinforced polymer concrete structures shall be manufactured and installed in accordance with the applicable requirements of ASTM C76, C478, C443, D6783, C33, C267, A82, A165, A496, A497, A615, and A615M.
- C. Manhole Frames and Covers: Provide manhole frames and covers as shown on the Collier County Standard details. Castings for manhole frames, covers and other items shall conform to the ASTM Designation A48, Class 30. Castings shall be true to pattern in form and dimensions and free of pouring faults and other defects in positions which would impair their strength, or otherwise make them unfit for the service intended. The scating surfaces between frames and covers shall be machined to fit true so the frames and covers do not shift under traffic

conditions or permit entry of storm water from flooding. Lifting or "pick" holes shall be provided, but shall not penetrate the cover. The words SANITARY SEWER, as well as COLLIER COUNTY shall be cast in all manhole covers except those owned by a private party. All manhole frames and covers shall be traffic bearing unless otherwise specified. Frames and covers shall be fully bedded in mortar to the correct finished grade elevation with materials shown in the COUNTY's Standard Detail Drawings.

- D. Preformed Joint Sealing Compound: Provide preformed joint sealing compound for joining manhole sections.
- E. Concrete Protective Liner: Provide concrete protective liner conforming to Section 02608.
- F. Pipeline Connections: Provide neoprene boots with type 316 stainless steel clamps of a design approved by the County Manager or designee for joining sewers to manhole riser sections. Fill the unfilled portion of the connection with mortar or concrete to guarantee a watertight seal.
- G. Doghouse Manholes: Doghouse manholes over existing sanitary sewer pipes are permitted, and in a number of instances, preferred. Provide a concrete base a minimum of 8 inches thick, with proper reinforcing rods to prevent cracking. Pour concrete base upon a 12-inch base of gravel. Precast manhole rings may be set in the concrete over the existing pipe. Concrete should then be used to form both the bench and to seal the pipe entrances, both inside and especially outside. Once dry, remove the top of the pipe in the manhole.
- H. Standard Manholes: The standard manhole shall be 4 feet or more in depth measured from the base of the cover frame to the top of the concrete footing and shall be of the concentric cone type, as shown in the Standard Details. If the manhole is 4 feet or less in depth, it shall be classified as a "Shallow Manhole" as specified below.
- I. Shallow Manholes: The shallow manhole shall be 4 feet or less in depth measured from the base of the cover frame to the top of the concrete footing and shall be of flat top construction, as shown in the Standard Details.
- J. Manhole Inverts: Form manhole inverts from concrete having a minimum 28 day compressive strength of 2500 psi, and as shown in the Standard Details. Inverts for "straight-through" manholes may be formed by laying the pipe straight through the manhole, pouring the concrete invert, and then cutting out the top half of the pipe. Construct curved inverts of concrete, as shown in the Standard Details, and form a smooth, even, half pipe section. Precast inverts may be used, however, no large "bowls" shall be permitted in the center of the manhole. To alleviate this problem, grout the invert to form a smooth, uniform invert as shown in the Standard Details. Maintain a 0.1 foot drop across the manhole.

- K. Inflow Protectors: In all manholes, install an inflow protector manufactured from a high-quality 304 stainless steel with a consistent thickness of not less than 18 gage (see County Approved Product List, Appendix F). The inflow shall have a deep-dish bowl design with no less than 8 inches in depth to allow easy and unobstructed removal of the manhole cover. The manhole inflow protector is to be manufactured with a one-piece rubber gasket installed at the factory for a tight, consistent fit. The rubber gasket is to be designed to securely wrap around the entire leading edge of the inflow protector at the point where it comes in contact with the manhole frame and cover. The wrap around rubber gasket is to be manufactured to a width of no less than 3/8 inches, consistent on top and bottom of the leading edge of the inflow protector. The gasket shall be no more than 3/32 inches thick. The insert removal handle shall be manufactured of a high-quality stainless steel for strength and durability. The handle is installed in such a way that it does not interfere with the installation or removal of the manhole lid. The insert handle will be manufactured to withstand a minimum pull force of 500 pounds before it fails or separates from the insert. The inscription "PROPERTY OF COLLIER COUNTY UTILITIES" shall be etched, at the base of the handle frame, to provide a long-lasting identification marker for the COUNTY.
- L. Chimney Seals: Install a minimum of two (2) precast concrete or HDPE riser rings with a chimney seal (see County Approved Product List, Appendix F) between manhole and cast iron frame.

2.3 SOURCE QUALITY CONTROL

- A. If requested by the County Manager or designee, at least three cylinders shall be taken each day that manhole sections are cast, with batch samples to be designated by the laboratory representative. At least one set of cylinders will be taken from each 9 cubic yards of concrete used in manhole section construction. These samples will be tested for strength. If the samples fail to meet specified minimum concrete strength requirements, all manhole sections manufactured from the concrete from which the cylinders were made will be rejected.
- B. The County Manager or designee reserves the right to core manholes either at the job site or point of delivery to validate strength of concrete and placement of steel. If cores fail to demonstrate the required strength or indicate incorrect placement of reinforcing steel, all sections not previously tested will be considered rejected until sufficient additional cores are tested, at no increase in Contract Amount, to substantiate conformance to these requirements.
- C. Components of the manhole shall be free of fractures, cracks, and undue roughness. Concrete shall be free of defects, which indicate improper mixing or placing, and surface defects such as honeycomb or spalling. Cracks or broken ends due to improper handling will not be acceptable. No lift holes will be allowed except in rise and corbel sections. These holes shall not penetrate the wall and shall be filled with non-shrink grout after installation.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Lifting Holes: Grout lifting holes through the structure with non-shrink grout.
- B. Precast Base: Provide a precast base of not less than 8 inches in thickness with a minimum dimension across the precast base of 72 inches poured monolithically with the bottom section of the manhole walls, reinforced, with a minimum 28-day compressive strength of 3000 psi.
- C. Joining Manhole Sections: Join precast sections using plastic joint sealing compound (see County Approved Product List, Appendix F) and trimmed prior to grouting. The first construction joint shall be not less than 2 feet above the base slab. Use tongue and groove joints suitable for the flexible gasket. Use non-shrink grout inside and outside for sealing between manhole precast sections. Grout shall be of a type acceptable to the County Manager or designee and designed for use in water. Seal all openings and joints watertight.
- D. Top Termination: Terminate manhole tops at such elevations as will permit laying up grade rings under the manhole frame to make allowances for future street grade adjustments.
- E. Drop Connections: Manufacture drop connections, where required on precast manholes, with the manhole elements at the casting yard. Drop manholes shall be constructed per the Collier County Standard Details.
- F. Internal Protection: Provide internal protection for all manholes by either of the following (not required for steel reinforced polymer concrete manholes as described in 2.2 B. above):
 - 1. Sewpercoat, or
 - 2. IET Coating system, or
 - 3. Raven Lining Systems

Install the coating systems per manufacturer's recommendation and completely protect the structure from corrosion. The liner or coating systems must extend and seal onto manhole ring, seal onto and around pipe openings, and any other protrusions, completely cover the bench and flow invert. Provide a five (5)-year unlimited warranty on all workmanship and products. The work includes the surface preparation and application of the coating or liner system, and shall protect the structure for at least five (5) years from all leaks and from failure due to corrosion from exposure to corrosive gases such as hydrogen sulfide.

Repair internal coating of existing manholes cored during tie-in of new sewers by applying approved coating material as listed above in accordance with the manufacturer's recommendations. If existing manhole has an internal coating

other than that listed above, sandblast the interior of the existing manhole and apply an approved coating in accordance with the manufacturer's recommendations.

- G. Coal Tar Epoxy: Coat all manhole, wet well, and valve vault exteriors with two (2) coats of coal tar epoxy to a minimum thickness of 8 dry mils (not required for steel reinforced polymer concrete manholes as described in 2.2 B. above).

END OF SECTION

SECTION 334713
HDPE IRRIGATION POND LINER

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Specifications and guidelines for MANUFACTURING and INSTALLING geomembrane.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
 - 2. D 1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
 - 3. D 1505 Test Method for Density of Plastics by the Density-Gradient Technique.
 - 4. D 1603 Test Method for Carbon Black in Olefin Plastics.
 - 5. D 3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.
 - 6. D 4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - 7. D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
 - 8. D 5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
 - 9. D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
 - 10. D 5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes.
 - 11. D 6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

12. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

B. Geosynthetic Research Institute

1. GRI GM 13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
2. GRI GM 17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

1.3 DEFINITIONS

- A. Lot- A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes. Finished roll will be identified by a roll number traceable to the resin lot used.
- B. Construction Quality Assurance Consultant (CONSULTANT) - Party, independent from MANUFACTURER and INSTALLER that is responsible for observing and documenting activities related to quality assurance during the lining system construction.
- C. ENGINEER- The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.
- D. Geomembrane Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geomembrane rolls.
- E. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY)- Party, independent from the OWNER, MANUFACTURER and INSTALLER, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the OWNER.
- F. INSTALLER- Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.
- G. Panel- Unit area of a geomembrane that will be seamed in the field that is larger than 100 ft².
- H. Patch- Unit area of a geomembrane that will be seamed in the field that is less than 100 ft².
- I. Subgrade Surface- Soil layer surface which immediately underlies the geosynthetic material(s).

1.4 SUBMITTALS POST-AWARD

- A. Furnish the following product data, in writing, to ENGINEER prior to installation of the geomembrane material:
 - 1. Resin Data shall include the following.
 - 2. Certification stating that the resin meets the specification requirements (see Section 1.09).
 - 3. Geomembrane Roll.
 - 4. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin (product run may be recycled).
- B. The INSTALLER shall furnish the following information to the ENGINEER and OWNER prior to installation:
 - 1. Installation layout drawings:
 - a. Must show proposed panel layout including field seams and details.
 - b. Must be approved prior to installing the geomembrane.
 - 2. Approved drawings will be for concept only and actual panel placement will be determined by site conditions.
 - 3. Installer's Geosynthetic Field Installation Quality Assurance Plan.
- C. The INSTALLER will submit the following to the ENGINEER upon completion of installation:
 - 1. Certificate stating the geomembrane has been installed in accordance with the Contract Documents.
 - 2. Material and installation warranties.
 - 3. As-built drawings showing actual geomembrane placement and seams including typical anchor trench detail.

1.5 QUALITY ASSURANCE

- A. The OWNER will engage and pay for the services of a Geosynthetic Quality Assurance Consultant and Laboratory to monitor geomembrane installation.

1.6 QUALIFICATIONS

- A. MANUFACTURER

1. See County Approved Product List, Appendix F, for approved geomembrane manufacturer.
2. MANUFACTURER shall have manufactured a minimum of 5000,000 square feet of polyethylene geomembrane during the last year.

B. INSTALLER

1. Installation shall be performed by the manufacturer approved dealer/installer.
2. INSTALLER shall have installed a minimum of 15,000 square feet of HDPE geomembrane during the last 3 years.
3. INSTALLER shall have worked in a similar capacity on at least 3 projects similar in complexity to the project described in the contract documents, and with at least 5,000 square feet of HDPE geomembrane installation on each project.
4. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.
5. The INSTALLER shall provide a minimum of one Master Seamer for work on the project.
 - a. Must have completed a minimum of 15,000 square feet of geomembrane seaming work using the type of seaming apparatus proposed for the use on this Project.

1.7 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

- A. Labeling - Each roll of geomembrane delivered to the site shall be labeled by the MANUFACTURER. The label will identify:
1. manufacturer's name
 2. product identification
 3. thickness
 4. length
 5. width
 6. roll number
- B. Delivery- Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

C. Storage- The on-site storage location for geomembrane material, provided by the CONTRACTOR to protect the geomembrane from punctures, abrasions and excessive dirt and moisture for should have the following characteristics:

1. level (no wooden pallets)
2. smooth
3. dry
4. protected from theft and vandalism
5. adjacent to the area being lined

D. Handling- Materials are to be handled so as to prevent damage.

1.8 WARRANTY

- A. Material shall be warranted, on a pro-rata basis against Manufacturer's defects for a period of 5 years from the date of geomembrane installation.
- B. Installation shall be warranted against defects in workmanship for a period of 1 year from the date of geomembrane completion.

1.9 GEOMEMBRANE

- A. Material shall be smooth/textured polyethylene geomembrane as shown on the drawings.
- B. Resin
 1. Resin shall be new, first quality, compounded and manufactured specifically for producing geomembrane.
 2. Natural resin (without carbon black) shall meet the following minimum requirements:

Property	Test Method	HDPE	LLDPE
Density [g/cm ³]	ASTM D 1505	0.932	0.915
Melt Flow Index [g/10 min.]	ASTM D 1238 (190/2.16)	• 1.0	• 1.0
OIT [minutes]	ASTM D 3895 (1 atm/200°C)	100	100

C. Geomembrane Rolls:

1. Do not exceed a combined maximum total of 1 percent by weight of additives other than carbon black.
2. Geomembrane shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.
3. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating roll number, thickness, length, width and MANUFACTURER.
4. All liner sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements listed in section 1.09, B, and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

D. Smooth surfaced geomembrane shall meet the requirements shown in the following table(s) for the following material(s):

Table 1.1: Minimum Values for Smooth Black-Surfaced HDPE Geomembranes

Property	Test Method ⁽¹⁾	Thicknes (mils)	Thicknes (mils)	Thicknes (mils)	Thicknes (mils)	Thicknes (mils)	Thicknes (mils)
Thickness, mil (mm)	ASTM D 5199						
Minimum Average		30 (0.75)	40 (1.0)	60 (1.5)	80 (2.0)	100 (2.5)	120 (3.0)
Lowest Individual Reading		27 (0.69)	36 (0.91)	54 (1.4)	72 (1.8)	90 (2.3)	108 (2.7)
Density, g/cm ³	ASTM D 1505	0.94	0.94	0.94	0.94	0.94	0.94
Carbon Black Content, %	ASTM D 1603, mod.	2.0	2.0	2.0	2.0	2.0	2.0
Carbon Black Dispersion	ASTM D 5596	Note 2	Note 2	Note 2	Note 2	Note 2	Note 2
	ASTM D 6693						
<i>Tensile Properties:</i> (each direction)							
Strength at Yield, lb/in (kN/m)		63 (11)	84 (15)	130 (23)	173 (30)	216 (38)	259 (45)
Strength at Break, lb/in (kN/m)	(1.3" gauge length)	122 (21)	162 (28)	243 (43)	324 (57)	405 (71)	486 (85)
Elongation at Yield, %	(2.0" gauge length)	13	13	13	13	13	13
Elongation at Break, %		700	700	700	700	700	700
Tear Resistance, lb (N)	ASTM D 1004	21 (93)	28 (124)	42 (187)	56 (249)	70 (311)	84 (373)
Puncture Resistance, lb (N)	ASTM D 4833	59 (263)	79 (352)	119 (530)	158 (703)	198 (881)	238 (1059)
Notched Constant Tensile Load, hours	ASTM D 5397, app.	400	400	400	400	400	400
Oxidative Induction Time, min.	ASTM D 3895	100	100	100	100	100	100

¹ Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

² Only near spherical agglomerates are considered. 9 of 10 views shall be Category 1 or 2. No more than one view Category 3.

- E. Textured surfaced geomembrane shall meet the requirements shown in the following table(s) for the following material(s).

Table 2.1: Minimum Values for Black Surfaced Coextruded Textured HDPE Geomembranes

Property	Test Method ⁽¹⁾	Thicknes (mils)	Thicknes (mils)	Thicknes (mils)	Thicknes (mils)	Thickness (mils)
Thickness, mil (mm)	ASTM D 5994	30 (0.75)	40 (1.0)	60 (1.5)	80 (2.0)	100 (2.5)
Minimum Average		27 (0.69)	36 (0.91)	54 (1.4)	72 (1.8)	90 (2.3)
Lowest Individual Reading						
Density, g/cm ³	ASTM D 1505	0.94	0.94	0.94	0.94	0.94
Carbon Black Content, %	ASTM D 1603, modified	2.0	2.0	2.0	2.0	2.0
Carbon Black Dispersion	ASTM D 5596	<i>Note 4</i>	<i>Note 4</i>	<i>Note 4</i>	<i>Note 4</i>	<i>Note 4</i>
	ASTM D 6693					
<i>Tensile Properties⁽²⁾: (each direction)</i>		63 (11)	84 (15)	130 (23)	173 (30)	216 (38)
Strength at Yield, lb/in (kN/m)		45 (8)	60 (11)	90 (16)	120 (21)	150 (27)
Strength at Break, lb/in (kN/m)	(1.3" gauge length)	13	13	13	13	13
	(2.0" gauge length)	150	150	150	150	150
Elongation at Yield, %	ASTM D 1004	21 (93)	28 (124)	42 (187)	56 (249)	70 (311)
Elongation at Break, %	ASTM D 4833	54 (240)	72 (320)	108 (480)	144 (641)	180 (801)
Tear Resistance, lb (N)	ASTM D 5397, appendix	400	400	400	400	400
Puncture Resistance, lb (N)	ASTM D 3895	100	100	100	100	100
Notched Constant Tensile Load ⁽³⁾ , hours						
Oxidative Induction Time, min.						

¹ Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

² The combination of stress concentrations due to coextrusion texture geometry and the small specimen size results in large variations of test results. Therefore, these tensile properties are minimum average roll values.

³ NCTL on coextruded textured product is conducted on representative smooth membrane samples.

⁴ Only near spherical agglomerates are considered. 9 of 10 views shall be Category 1 or 2. No more than one view Category 3.

F. Extrudate Rod or Bead:

1. Extrudate material shall be made from same type resin as the geomembrane.
2. Additives shall be thoroughly dispersed.
3. Materials shall be free of contamination by moisture or foreign matter.

1.10 EQUIPMENT

A. Welding equipment and accessories shall meet the following requirements:

1. Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.
2. An adequate number of welding apparati shall be available to avoid delaying work.

3. Power source must be capable of providing constant voltage under combined line load.

1.11 DEPLOYMENT

- A. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site.
- B. Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.
- C. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:
 1. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage (spreader bar, protected equipment bucket).
 2. Place ballast (commonly sandbags) on geomembrane which will not damage geomembrane to prevent wind uplift.
 3. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geomembrane.
 4. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than 6 psi.
 5. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.
- D. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

1.12 FIELD SEAMING

- A. Seams shall meet the following requirements:
 1. To the maximum extent possible, orient seams parallel to line of slope, i.e., down and not across slope.
 2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.
 3. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.
 4. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the CONSULTANT and INSTALLER.

5. Align seam overlaps consistent with the requirements of the welding equipment being used. A 6-inch overlap is commonly suggested.

B. During Welding Operations

1. Provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

C. Extrusion Welding

1. Hot-air tack adjacent pieces together using procedures that do not damage the geomembrane.
2. Clean geomembrane surfaces by disc grinder or equivalent.
3. Purge welding apparatus of heat-degraded extrudate before welding.

D. Hot Wedge Welding

1. Welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.
2. Clean seam area of dust, mud, moisture and debris immediately ahead of hot wedge welder.
3. Protect against moisture build-up between sheets.

E. Trial Welds

1. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.
2. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.
3. Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.
4. Cut four, one-inch wide by six-inch long test strips from the trial weld.
5. Quantitatively test specimens for peel adhesion, and then for shear strength.
6. Trial weld specimens shall pass when the results shown in Table 3 are achieved in both peel and shear test.

- a. The break, when peel testing, occurs in the liner material itself, not through peel separation (FTB).
 - b. The break is ductile.
 - 7. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.
 - 8. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.
- F. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. INSTALLER shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.
- G. Defects and Repairs
- 1. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
 - 2. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

1.13 FIELD QUALITY ASSURANCE

- A. MANUFACTURER and INSTALLER shall participate in and conform to all terms and requirements of the Owner's quality assurance program. CONTRACTOR shall be responsible for assuring this participation.
- B. Quality assurance requirements are as specified in this Section and in the Field Installation Quality Assurance Manual if it is included in the contract.
- C. Field Testing
- 1. Non-destructive testing may be carried out as the seaming progresses or at completion of all field seaming.
 - a. Vacuum Testing
 - (1) Shall be performed in accordance with ASTM D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
 - b. Air Pressure Testing

- (1) Shall be performed in accordance with ASTM D 5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
 - c. Other approved methods.
2. Destructive Testing (performed by CONSULTANT with assistance from INSTALLER)
 - a. Location and Frequency of Testing
 - (1) Collect destructive test samples at a frequency of one per every 1500 lineal feet of seam length.
 - (2) Test locations will be determined after seaming.
 - (3) Exercise Method of Attributes as described by GRI GM-14 (Geosynthetic Research Institute, <http://www.geosynthetic-institute.org>) to minimize test samples taken.
 - b. Sampling Procedures are performed as follows:
 - (1) INSTALLER shall cut samples at locations designated by the CONSULTANT as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.
 - (2) CONSULTANT will number each sample, and the location will be noted on the installation as-built.
 - (3) Samples shall be twelve (12) inches wide by minimal length with the seam centered lengthwise.
 - (4) Cut a 2-inch wide strip from each end of the sample for field-testing.
 - (5) Cut the remaining sample into two parts for distribution as follows:
 - (a) One portion for INSTALLER, 12-inches by 12 inches
 - (b) One portion for the Third Party laboratory, 12-inches by 18-inches
 - (c) Additional samples may be archived if required.
 - c. Destructive testing shall be performed in accordance with ASTM D 6392, Standard Test Method for Determining the Integrity of Non-

Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

- d. INSTALLER shall repair all holes in the geomembrane resulting from destructive sampling.
- e. Repair and test the continuity of the repair in accordance with these Specifications.

D. Failed Seam Procedures

- 1. If the seam fails, INSTALLER shall follow one of two options:
 - a. Reconstruct the seam between any two passed test locations.
 - b. Trace the weld to intermediate location at least 10 feet minimum or where the seam ends in both directions from the location of the failed test.
 - c. The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than 10 feet long.
 - d. If sample passes, then the seam shall be reconstructed or capped between the test sample locations.
 - e. If any sample fails, the process shall be repeated to establish the zone in which the seam shall be reconstructed.

1.14 REPAIR PROCEDURES

- A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.
- B. Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test.
- C. INSTALLER shall be responsible for repair of defective areas.
- D. Agreement upon the appropriate repair method shall be decided between CONSULTANT and INSTALLER by using one of the following repair methods:
 - 1. Patching- Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.
 - 2. Abrading and Re-welding- Used to repair short section of a seam.
 - 3. Spot Welding- Used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.

4. Capping- Used to repair long lengths of failed seams.
 5. Flap Welding- Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.
 6. Remove the unacceptable seam and replace with new material.
- E. The following procedures shall be observed when a repair method is used:
1. All geomembrane surfaces shall be clean and dry at the time of repair.
 2. Surfaces of the polyethylene which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.
 3. Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and around all corners of patch material.
- F. Repair Verification
1. Number and log each patch repair (performed by CONSULTANT).
 2. Non-destructively test each repair using methods specified in this Specification.

1.15 MEASUREMENT AND PAYMENT

- A. Payment for geomembrane installation will be as per contract unit price per square foot, as measured parallel to liner surface, including designed anchor trench material and is based upon net lined area.
- B. Net lined area is defined to be the true area of all surfaces to be lined plus designed burial in all anchor trenches, rubsheets, and sacrificial layers.
- C. Prices shall include full compensation for furnishing all labor, material, tools, equipment, and incidentals.

END OF SECTION

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SECTION 409500

FIBER-OPTIC COMMUNICATION STANDARDS

PART 1 GENERAL

1.1 OVERVIEW

- A. The standards herein pertain to all work associated with the procurement, installation, configuration, and testing of fiber-optic communications and associated infrastructure for County installations.
- B. All contractors and subcontractors selected to perform fiber-optic communications work for the County shall adhere to the standards described in this document.
- C. Additional requirements may be defined in engineering plans related to the fiber-optic communications work performed. In the event of a conflict, the most stringent requirement shall be followed. In the event of a conflict where the most stringent requirement cannot be resolved, Contractor shall inform County in writing identifying the discrepancy for final direction.

1.2 DEFINITIONS

A. Common Abbreviations

- 1. Amps: Ampere.
- 2. ANSI: American National Standards Institute.
- 3. ASTM: American Society for Testing and Materials.
- 4. AWG: American Wire Gauge.
- 5. CCITD: Collier County Information Technology Department.
- 6. CFR: Code of Federal Regulations.
- 7. dB: Decibel.
- 8. EIA: Electronic Industries Alliance.
- 9. FDEP: Florida Department of Environmental Protection.
- 10. HASB: High Airspeed Blowing.
- 11. HDPE: High Density Polyethylene.
- 12. IT: Information Technology.
- 13. km: Kilometer.
- 14. lbs: Pounds.
- 15. m: Meter.
- 16. N: Newton.

17. NEC: National Electric Code.
18. NEMA: National Electrical Manufacturers Association.
19. NESC: National Electrical Safety Code.
20. nm: Nanometer.
21. OSHA: Occupational Safety and Health Administration.
22. OTDR: Optical Time Domain Reflectometer.
23. PVC: Polyvinyl Chloride.
24. RCDD: Registered Communications Distribution Designer.
25. RUS: United States Rural Utilities Service.
26. SC: Subscriber Connection.
27. SDR: Standard Dimension Ratio.
28. SMF: Single Mode Fiber.
29. SRM: Standard Route Marker.
30. TIA: Telecommunications Industry Association.
31. UV: Ultraviolet.
32. VAC: Volts Alternating Current.
33. WGU: Wire Grounding Unit.

1.3 COORDINATION ACTIVITIES

- A. Work involving the installation of fiber-optic cabling and equipment will interface with equipment provided by Others including, but not limited to, the following:
 1. Mounting of the IT Telecommunications Panel
 - a. The IT telecommunications panel shall be mounted to an equipment rack at the installation site. Refer to County Utility Detail G-12.
- B. Contractor shall determine all interface and installation requirements at the site prior to procurement and delivery and coordinate as required with County.
- C. Permitting:
 1. Contractor is responsible for determining and obtaining all necessary permits for the work being performed, including, but not limited to:
 - a. Stormwater.
 - b. Utilities.
 - c. Right-of-way.
 - d. Canal crossings [South Florida Water Management District].
 - e. FDEP.
 2. Contractor is responsible for all permitting fees.

1.4 QUALITY ASSURANCE

- A. Contractor Qualifications:

1. Contractor shall be firms, corporations, individuals, or partnerships normally engaged in the deployment, maintenance, and repairs of fiber-optics at the municipal, county or state level.
2. Contractor shall have one or more of the following certifications
 - a. Registered Communications Distribution Designer (RCDD)
 - b. IMSA Fiber Optics for Traffic Stem Technician 2
 - c. IMSA Traffic Signal Technician Level 2
 - d. IMSA Traffic Signal Technician Level 3
3. Contractor shall have a minimum of 5 years of experience performing fiber-optic communications work based on the relevant scope definition category or categories above.

PART 2 PRODUCTS

2.1 GENERAL

- A. Each subsection below specifies the minimum requirements for each type of product. Contractor shall adhere to product requirements below unless otherwise approved by County in writing.

2.2 FIBER-OPTIC CABLE

- A. General: Provide all-dielectric, dry-filled, loose-tube, dispersion-unshifted, single-mode fiber (SMF) with low water peak, gel free, and suitable for underground (i.e., in conduit) and aerial outside plant installation. All fiber optic cable shall be splice-compatible with existing dispersion-unshifted SMF and require no electronic equipment for dispersion compensation between new and existing fiber. Ensure that all components that comprise a single length of cable are continuous and of the same material. Furnish only commercial off-the-shelf materials, equipment, and components.

B. Optical Fibers:

1. Ensure that the optical fibers used in the cable meet or exceed the Telecommunications Industry Association (TIA) and Electronic Industries Alliance (EIA) TIA/EIA-492-CAAB specification, the U.S. Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900, and International Telecommunication Union ITU-T G.652.D requirements. Use only optical fibers meeting the additional requirements as follows:
 - a. Optical:
 - 1) Cabled Fiber Attenuation:
 - a) 1310 nm; Less than or equal to 0.35 dB/km.
 - b) 1550 nm; Less than or equal to 0.25 dB/km.
 - 2) Point Discontinuity:
 - a) 1310 nm; Less than or equal to 0.05 dB/km.
 - b) 1550 nm; Less than or equal to 0.05 dB/km.

2. Ensure that all fiber in the buffer tube is usable fiber that complies with attenuation requirements. Ensure that fibers do not adhere to each other. Ensure that the fiber is free of surface imperfections and inclusions. Ensure that all fiber optic core glass is from the same manufacturer.

C. Buffer Tubes: Ensure that the fiber optic cable includes loose buffer tubes that isolate internal optical fibers from outside forces and provide protection from physical damage as well as water ingress and migration. Ensure that buffer tubes provide freedom of movement for internal optical fibers. Ensure buffer tubes allow for expansion and contraction of the cable without damage to internal optical fiber. Ensure that fiber does not adhere to the inside of the tube. Ensure that buffer tubes permit intentional scoring and breakout without damage to the fiber. Ensure that each fiber optic cable buffer tube contains 12 fibers per tube.

D. Color Code:

1. Ensure that the marking and color-coding of the fibers and buffer tubes conforms to the TIA-598-D standard.
2. Ensure that colors are permanent and stable during temperature cycling, and not subject to fading or smearing onto each other or into the water-blocking material. Ensure that fibers are colored with UV curable inks that remain clearly distinguishable as the intended color.

E. Strength Member: Ensure that the fiber optic cable contains a dielectric central and outside elements that prevent buckling of the cable and provide tensile strength. Ensure that the fiber optic cable can withstand a pulling tension of 600 lbs. without damage to any components of the fiber optic cable.

F. Outer Jacket:

1. Mark the jacket with the cable manufacturer's name, fiber type, fiber count, date of manufacture", and the sequential cable lengths marked in feet. All fiber-optic cabling shall have a stripe, yellow in color, along the entire length of the cable, and shall be marked "Collier County BCC IT" at three-foot intervals. Provide legible marking with contrasting color to that of the cable jacket.

G. Performance:

1. Bend radius: Ensure that the fiber optic cable is capable of withstanding a minimum unloaded bend radius of 10 times the cable diameter and a minimum loaded bend radius of 20 times the cable diameter when loaded to pulling tension of 600 pounds. Test the cable as required in the TIA -455-33B standard. Ensure that bending the fiber optic cable up to the minimum bend radius does not affect the optical characteristics of the fiber.

2. Cable Strength: Ensure that the fiber optic cable is capable of withstanding a pulling tension of 600 pounds during installation without increasing the fiber attenuation more than 0.8 dB/mile and without changing other optical fiber characteristics after the tensile load is removed. Ensure that optical fiber is proof-tested by the fiber manufacturer at a minimum of 100 kilo pounds per square inch. Ensure that the cable will withstand 25 impact cycles and the change in attenuation does not exceed 0.2 dB at 1550 nm when tested according to the requirements as detailed in the TIA -455-25D standard. Ensure that the change in attenuation will not exceed 0.15 dB during loading at 1550 nm, and that no fiber displays a measurable change in attenuation after load removal.

2.3 FIBER-OPTIC CONNECTION HARDWARE

A. General: Ensure that all splice enclosures, organizers, cable end preparation tools, and procedures are compatible with the fiber optic cable, and are approved by the County in writing.

B. Splice Enclosures:

1. Contain all optical fiber splices within a splice enclosure. Ensure that the enclosures provide storage for splices, fiber, and buffer tubes. Ensure that the splice enclosure restores the mechanical and environmental integrity of the fiber optic cable, encases the sheath opening in the cable, and organizes and stores optical fiber. Ensure all hinges and latching devices are stainless steel. Ensure that the enclosure is airtight and prevents water intrusion. Ensure that the splice enclosure can accommodate pressurization and has the ability to be reentered without requiring specialized tools or equipment. Ensure that the enclosure provides fiber and splice organizers including splice trays and strain relief.
2. Ensure that splice enclosures are hermetically sealed to protect internal components from environmental hazards such as moisture, insects, and UV light. Fiber optic splice enclosures shall also:
3. Comply with the Telcordia Technologies' GR-771-CORE standard and all applicable NEC requirements.
4. Provide space for future expansion equal to 100% of the initial utilization.
5. Provide fiber optic cable penetration end caps to accommodate a minimum installation of two trunk fiber optic cables and two fiber optic drop cables. Ensure that the enclosure end caps are factory-drilled to the proper diameter to accept and seal the fiber optic cable entries. Ensure that the cable entry locations can accommodate an assortment of cables with outside diameters ranging from 0.45 inches to 0.55

inches, plus 10%, without jeopardizing the waterproof characteristics of the enclosure.

C. Splice Trays: Ensure that splice trays are securely attached and accessible and provide sufficient storage for the fiber cable. Ensure splice trays provide access to individual fibers without disrupting other fibers in the tray. Ensure that splice trays hold the buffer tubes rigidly in place and provide protection for fusion splices. Ensure that the raceway accommodates the minimum bend radius of the fiber. Ensure that splice trays allow visible inspection of the fiber. Ensure that splice trays include a cover with a locking mechanism to hold it in place.

D. Cable Terminations:

1. Use Type SC connectors for all new network installations. Ensure that all connectors include a ceramic ferrule and provide a strain relief mechanism when installed on a single fiber cable that contains strength elements. Ensure that the optical fiber within the body of all connectors is mechanically isolated from cable tension, bending, and twisting.

E. Pre-Terminated Connector Assemblies: Ensure that pre-terminated cable assemblies consist of fiber optic cables with factory-installed connectors on one end of the cable and an un-terminated optical fiber on the other. Ensure that the pre-terminated connector assemblies are installed with fusion splices. Ensure that all buffer tubes and fibers are protected once the attachment of pre-terminated connector assemblies is complete.

F. Buffer Tube Fan-Out Kits: Ensure that a buffer tube fan-out kit is installed when fiber optic cables are terminated. Use a kit compatible with the fiber optic cable being terminated and that is color-coded to match the optical fiber color scheme. Ensure that the buffer tube fan-out kit supports 12 fiber strands.

G. Patch Panels:

1. Ensure that the patch panel is compatible with the fiber optic cable being terminated and color coded to match the optical fiber color scheme. Ensure that the patch panel has a minimum of 12 SC-type panel connectors unless otherwise shown in the Plans. Ensure that the patch panel dimensions do not exceed 14 inches x 6 inches x 4 inches for fiber counts of twelve or less. Ensure the patch panel is suitable for mounting within an approved cabinet at the field device location. Ensure patch panels are sized to accommodate specified coupler housings and maintain sufficient bend radius for cables. Ensure the patch panel is sized to occupy the minimum space required for capacity.
2. Connector Panels:

- a. Ensure that the connector panel provides 12 SC-type, bulkhead-mount coupling connectors. Ensure that each coupling connector allows connection of a cable terminated on one side of the panel to a cable on the opposite side.

2.4 IT TELECOMMUNICATIONS PANEL

A. General:

1. Function: Receive incoming fiber-optic cable at installation site from County network.
2. Major parts include fiber-optic patch panel, network cabling, and accessories.

B. Enclosure Specifications:

1. Manufacturers and Products:
 - a. American Products; AP Minifort Model AM-462418-24RU.
 - b. No substitutions.
2. Panel Size:
 - a. Include mounting bracket accessory from panel manufacturer for installation.
 - b. Increase panel size if and as needed to accommodate additional network equipment or to increase heat dissipation to reach an internal steady-state operating temperature below the maximum operating temperature of all contained equipment.
3. Provide ground bar inside enclosure.
4. All conduit penetrations shall be made through the bottom face of the enclosure. Side or top penetrations are not acceptable.
5. Include quad 120 VAC power receptacle gang box inside enclosure.
6. Enclosure shall include a standard rack for mounting of rack-mounted equipment.

2.5 CONDUIT

A. Materials of Construction: Use materials that have been tested and listed by a Nationally Recognized Testing Laboratory to the following industry standards:

- High Density Polyethylene (HDPE):
 - For use outside site boundaries, such as roadside pull boxes and splice enclosures.
- HDPE Standard Dimension Ratio (SDR) 13.5: ASTM F2160, NEMA TC-7
- All HDPE conduit shall be orange in color.
- Schedule 80 PVC:
 - For use inside site boundary for interconnection of fiber-optic equipment and to on-site fiber-optic handholes, pull boxes, and splice enclosures.

- B. Locate Wire: Ensure that locate wire is a single copper solid conductor with a minimum gauge of No. 12 AWG with blue shielding. Ensure locate wire is insulated using a 45-millimeter minimum thickness polyethylene sheath that is orange in color and marked to identify the manufacturer and the conductor size.
- C. Locate Wire Grounding: Ensure that locate wires are attached to a wire grounding unit (WGU) dedicated to safely dissipate high transient voltages or other foreign electrical surges induced into the designated system. Ensure the WGU conforms to the following:
1. Allows signals generated by locate system transmitters to pass through the protection system without going to ground.
 2. The protection system automatically resets and passes locate system transmitter signals after the unit has been grounded to dissipate over-voltages.
 3. Is intended for below or above grade applications. Ground the WGU to a driven rod within 10 feet of the system using a No. 6 AWG single conductor wire with green insulation.
 4. The WGU system meets the minimum standards listed below for surge protection:
 - a. Surge Element: Three-element maximum duty fail-safe gas tube.
 - b. Rating: 40,000 Amp surge capacity (single-cycle, 8 by 20 microsecond waveform).
 - c. Life: Minimum 1,000 surges (1000 Amps to ground).
 - d. Insulation Resistance: 1,000 megohm minimum at 100 volts of direct current.
 - e. Clamp Voltages:
 - 1) Impulse at 100 volts per microsecond.
 - 2) Direct Current: 300 to 500 volts.
- D. Route Markers:
1. Ensure Standard Route Marker (SRM) is a rigid, three-sided driven post used for location and notification purposes only.
 2. Ensure that each SRM is labeled and identified as a County IT fiber optic cable marker unless otherwise shown in the Plans. The labels must include the contact information for the Collier County IT department, and a telephone number to call prior to any excavation in the area. Ensure that the identification information is permanently imprinted on the top fitting, and will not peel, fade, or deteriorate.
 3. Ensure that SRM posts are white with an orange top fitting cover with black or white lettering and graphics. Ensure that the SRM is a tubular configuration, and both the marker post and the top fitting are made

from virgin Type 111 HDPE. Ensure that any fasteners used with the SRM are constructed of stainless steel.

4. Ensure that all SRMs have a minimum outside diameter of 3.5 inches with a minimum wall thickness of 0.125 inches. Ensure that the top fitting cover is a minimum of 1.5 feet long and has an outside diameter of 3.75 inches with a minimum wall thickness of 0.125 inches. Ensure that each SRM provides a tensile strength of 4,200 pounds per square inch as required in ASTM D638. Ensure that each SRM is manufactured for use in temperatures range of minus 30° to 165°F in accordance with NEMA TS 2.
5. Ensure the SRM can withstand an impact force of 70 pounds per foot at 32°F in accordance with ASTM D2444, before and after UV conditioning for 2,000 hours in accordance with ASTM G154. Ensure that the control sample of any material tested maintains a minimum of 70 percent of its original tensile strength.
6. Ensure that SRMs installed at the minimum 2-foot depth can withstand at least one impact at 45 miles per hour by a vehicle weighing at least 3,500 pounds and that after impact, post returns to an upright position within 10 degrees of vertical alignment within 30 seconds from the time of impact.

2.6 PULL AND SPLICE BOXES

A. General:

1. The box bodies and covers shall be free of flaws such as cracks, sharp, broken, or uneven edges, and voids.
2. Ensure in-ground boxes have an open bottom design.

B. Marking:

1. The following information shall be permanently cast or engraved into the top surface of all pull and splice box covers. If used, identification plates shall be UV stable, mechanically fastened, and bonded with adhesive material suitable for outdoor applications.
 - a. Mark application as "COMMUNICATIONS"
 - b. Manufacturer's name or logo.

C. Dimensions:

1. For fiber optic cable applications, pull boxes with nominal cover dimensions of 24 inches wide by 36 inches long or larger and no less than 18 inches deep shall be provided.
2. Rectangular splice boxes with nominal cover dimensions of 30 inches wide by 48 inches long or larger and no less than 18 inches deep shall be provided.

D. Fabrication:

1. Box covers shall be constructed of concrete, polymer concrete or other materials meeting the requirements of this Section.
2. Box covers with lifting slots and a flush-seating lockdown mechanism shall be provided. Penta-head or other non-standard, security type lockdown lag bolts shall be used. Lockdown bolts and lifting slots shall be Type 316, 304, or 302 passivated stainless steel or brass. Lockdown bolt assembly shall be designed to prevent seizing and can be removed without damaging the cover or box body. The lockdown bolt threaded insert/nut assembly shall be field replaceable.
3. The box construction shall be an ANSI Tier 22 Quazite brand enclosure.

PART 3 EXECUTION

3.1 PREPARATION

A. Conduit:

1. Ensure installed conduit system conforms to fiber-optic system requirements, including:
 - a. Conduits: Size and number.
 - b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables may be installed without exceeding manufacturer's limitations.
 - c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
2. Expansion Plugs: Seal conduit to stop ingress of water and grit with fabricated expansion plugs.
3. Ensure duct bank, conduit, and other confined routing is free and clear of debris before cable placement.

3.2 SOURCE QUALITY CONTROL

- A. Cable End Sealing: Ensure that fiber optic cable ends are capped or sealed to prevent the entry of moisture during shipping, handling, storage, and installation. Equip one end of the fiber optic cable with flexible pulling eyes.
- B. Protective Wrap: Ensure that the fiber optic cable is shipped and stored with a protective wrap or other approved mechanical reel protection device over the outer turns of the fiber optic cable on each reel. Ensure that the wrap is weather resistant and protects the cable reel from environmental hazards. Ensure that the cable reel remains wrapped until cable is to be installed.
- C. Packaging, Shipping and Receiving: Ensure that the packaging and delivery of fiber optic cable reels comply with the following minimum requirements:

1. Ensure cable is shipped on reels of marked continuous length.
2. Ensure each cable is shipped on a separate, strongly constructed reel designed to prevent damage to the cable during shipment and installation.
3. Ensure each reel has a minimum of 6 feet on each end of the cable available for testing.
4. Ensure that all fiber optic cable is continuous and free from damage.
5. Ensure no point discontinuities greater than 0.1 dB per reel.
6. Ensure satisfactory transmission loss test results as required by the TIA-455-61-A standard.
7. Ensure that the manufacturer submits the date of manufacture; product and serial numbers; cable data, including the reel length; refraction index; the project name and location; type of fiber and quantity of strands used; technical product data sheets; and reel numbers.

D. Manufacturer Testing and Certification: Submit documentation of all factory tests performed by the manufacturer for all fiber optic cable, splicing material, cable terminations, and patch panels as requested by the County.

3.3 INSTALLATION

A. Fiber-Optic Cable Installation:

1. Install all materials and equipment according to the latest version of the manufacturer's installation procedures. Ensure that all materials and installation practices are in accordance with the applicable OSHA requirements as found in 29 CFR Part 1926, Safety and Health Standards for Construction. In addition, perform the following:
 - a. Ensure conduit and innerduct is clean and free from damage prior to installing fiber optic cable.
 - b. Document the sequential cable length markings at each splice box and pull box wall that the cable passes through and include the information with the as-built documentation.
2. Provide all incidental parts needed to complete the installation as necessary for a complete and properly operating system.
3. Cable Identification:
 - a. All fiber cable shall be striped with a yellow color along the entire length of the cable.
 - b. A cable tag with permanent ink shall denote "COLLIER COUNTY BCC IT FIBER-OPTIC CABLE" shall be affixed on the cable at every 3-foot interval.
4. Pulling:
 - a. Install the fiber optic cable by hand or by using a mechanical pulling machine. If a mechanical pulling machine is used, equip the machine with a monitored or recording tension meter.

- Ensure that at no time the manufacturer's recommended maximum pulling tension is exceeded. Ensure that the central strength member and aramid yarn are attached directly to the pulling eye during cable pulling. Use pulling attachments to ensure that the optical and mechanical characteristics are not degraded during the fiber optic cable installation.
- b. Ensure that excess cable is coiled in a figure eight and fed manually when pulling through pull boxes and splice boxes by hand. If pulleys and sheaves will be used to mechanically pull through pull boxes and splice boxes, ensure that the cable will never be pulled through a radius less than the manufacturer's minimum bend radius. Use large diameter wheels, pulling sheaves, and cable guides to maintain the appropriate bend radius. Provide tension monitoring at all times during the pulling operation. Ensure that cable pulling lubricant used during installation is recommended by the optical fiber cable manufacturer.
5. Blowing: Use either the high airspeed blowing (HASB) method or the piston method. When using the HASB method, ensure that the volume of air passing through the conduit does not exceed 600 cubic feet per minute or the conduit manufacturer's recommended air volume, whichever is more restrictive. When using the piston method, ensure that the volume of air passing through the conduit does not exceed 300 cubic feet per minute or the conduit manufacturer's recommended air volume, whichever is more restrictive.
6. Slack Cable Storage: Provide and store fiber optic cable at each pull box and splice box to allow for future splices, additions, or repairs to the fiber network. Store the fiber optic cable without twisting or bending the cable below the minimum bend radius.
- a. Store a total of 200 feet of fiber optic backbone cable in splice boxes, with 100 feet of cable on each side of the cable splice point.
 - b. Store a minimum of 100 feet of fiber optic drop cable in splice boxes.
 - c. Store 100 feet of spare fiber optic cable in pull boxes.
7. Fiber Optic Connection - Splicing:
- a. Perform all optical fiber splicing using the fusion splicing technique, and according to the latest version of the manufacturer's cable installation procedures, industry accepted installation standards, codes, and practices. Ensure that all splices match fiber and buffer tube colors.
 - b. Ensure that splice loss does not exceed a maximum of 0.05 dB per splice as measured on the fusion splice machine when splicing newly installed fibers together. Ensure that splice loss does not exceed a maximum of 0.1 dB per splice as measured

on the fusion splice machine when splicing newly installed fibers to existing fibers.

- c. Where a fiber cable is to be accessed for lateral or drop signal insertion, only open the buffer tube containing the fiber to be accessed and only cut the actual fiber to be accessed. If a fiber end is not intended for use, cut the fiber to a length equal to that of the fiber to be used and neatly lay it into the splice tray.
- d. Treat any fibers exposed during splicing with a protective coating and place in a protective sleeve or housing to protect the fiber from damage or contaminants. Neatly store all splice enclosures within a splice box.

- 8. Splice Plan: Submit a splice plan showing the location and configuration of splices in the system for approval by the County. Perform all splicing according to the splice plan. Document each splice location and identify the source and destination of each fiber in each splice tray. Document all fiber colors and buffer jacket colors used during installation and develop a sequential fiber numbering plan as required in the TIA -598-D standard for color-coding in the documentation.
- 9. Splice Equipment: Use a fusion splice machine to splice all optical fiber. Ensure that splice equipment is new from the factory, or equipment has been serviced and certified by the factory or its authorized representative within the previous 12 months from the commencement of its use. Ensure that the calibration certificate is maintained in the splicing equipment case or provided electronically when requested. Clean all splicing equipment and calibrate according to the manufacturer's recommendations prior to each splicing session at each location.

B. Cable Termination Installation: Ensure that cables, buffer tubes, or strands are neatly routed, secured, and terminated in a patch panel in coordination with the County. Ensure all cable termination points include documentation regarding the identification, route, and function of each fiber installed at that location. Ensure that a copy of this information is placed alongside the installed equipment (for instance, in a document pouch or drawer within a field cabinet).

C. Patch Panel Installation: Ensure that patch panels are neatly installed and secured in a weather-proof enclosure.

D. Conduit Installation:

- 1. Install the conduit in accordance with NEC or National Electrical Safety Code (NESC) requirements and the Standard Plans. Construct conduit runs as straight as possible. Mark the location of the conduit system

with route markers every 1,000 feet and at every pull box and splice box. Ensure that all route markers used are new and consistent in appearance.

2. Install a No. 12 AWG pull wire or polypropylene cord inside the full length of all conduits. Ensure that a minimum of 24 inches of pull wire/cord is accessible at each conduit termination.
3. Ensure the conduit includes all required fittings and incidentals necessary to construct a complete installation.
4. Prevent the ingress of water, dirt, sand, and other foreign materials into the conduit prior to, during, and after construction. Seal the ends of conduit after wiring is complete with a moisture resistant sealant that is designed for this specific application.
5. Install the conduit system so the fiber optic cable maintains the minimum bend radius. Use approved methods for connecting inner duct or conduit within or between plowed portions, trenched portions, and bored portions. Coupling method and material to be in compliance with manufacturer's installation guidelines.
6. Conduit Terminations:
 - a. Where conduit enters a box, fitting, or other enclosure, provide a bushing or adapter (end bell, conduit adapter, etc.) to protect the conductor or cable from abrasion unless the box, fitting, or enclosure provides equivalent protection.
 - b. For conduit to be encased in concrete, wrap with tape, or otherwise protect all terminations to prevent the entrance of concrete.
 - c. Connect new underground conduits to existing underground conduits with a pull box.
 - d. Seal conduits terminating in a pull box or junction box with a moisture resistant sealant.
7. Restoration of Trench Areas: Restore the conduit trench construction area to an acceptable condition. Such work includes repair or replacement of all pavement areas, sidewalks, driveways, curbs, structures, landscaping, grass areas (including removal of excavated materials and spoils), removal and disposal of drilling fluids, and backfilling areas disturbed by the conduit installation.
8. Above-Ground Installation
 - a. Use conduit designed and manufactured for use in long-term above-ground applications with UV stabilization to prevent material deterioration.
 - b. Securely attach above-ground conduit installations to the surface of the supporting structure using conduit straps. As a minimum, use conduit straps located on 5-foot centers.
9. Elbow Curvature:
 - a. For 2-inch conduit, the radius of curvature of the centerline of any bend shall not be less than 9.5 inches.

E. Fiber-Optic Cable Locate Wire:

1. Installation:
 - a. Install locate wire in the trench or bore with all underground conduits to provide end-to-end electrical continuity for electronically locating the underground conduit system. When conduit is placed by trenching, bury locate wire along the centerline of the top outer surface of installed conduit.
 - b. Do not run locate wires into field cabinets. Terminate locate wires at the following locations or as shown on the Plans, nearest pull box to a field cabinet, nearest pull box to a building, and splice box locations. Ensure that wire termination occurs in a pull box.
 - c. Install WGUs in pull boxes and splice boxes as shown in the Plans. Mount the device in a location high enough from the bottom of the box to allow access to terminal facilities without disturbing cables present within the box. Terminate the locate wires and connect the WGU to ground in accordance with the manufacturer's instructions.
2. Testing: Test the locate wire system after installation to ensure that it functions and can be used to accurately locate the conduit system. Perform continuity tests and insulation resistance tests on all locate wires. Replace, or repair defective locate wire at no additional cost.

F. Route Markers:

1. Install route markers for new fiber optic cable installations, replace route markers as shown in the Plans, and ensure the following:
 - a. Markers are plumb and level and the notification information is clearly visible when viewed from the side facing the roadway.
 - b. Markers are set within the right of way.
 - c. Markers are placed at a one-foot offset from the conduit system.
 - d. The top of the marker post is a minimum of five feet and maximum of six feet above the finish grade
 - e. Place marker at each pull box location.
 - f. Markers are installed on both sides of a stream, river, or other water crossing, and on both sides of aboveground attachments such as bridges and walls.
2. Remove and replace all marker posts damaged during installation at no additional cost. Provide as-built documentation at the completion of installation that includes location of all installed route markers and correlates the marker to the fiber optic infrastructure that it signifies.

G. Pull and Splice Boxes:

1. Do not install power and communication cables in the same box.

2. Install pull and splice boxes in accordance with Plans. Ensure that the pull or splice box cover is flush with the concrete apron or sidewalk. Prior to installation, pour in a bed of pea rock or crushed stone at least one foot deep, with horizontal dimensions four inches longer than the width and length of the pull box. The pull or splice box installation shall be placed so that the inside edge of the box rests entirely on a gravel bed. Do not install pull or splice boxes in roadways, driveways, parking areas, ditches, or public sidewalk curb ramps. Avoid placing pull and splice boxes in low-lying locations with poor drainage. Ensure that pull and splice boxes house fiber optic cable without exceeding the cable bend radius.
3. Provide conductive metal ground rod that is at least 5/8 inches in diameter and 48 inches long. Ground rod shall be installed vertically within three inches of the inside edge of the pull or splice box, with at least 10 inches of the rod exposed above the gravel base.
4. Placement and Spacing: Pull boxes shall be spaced a maximum of 1,000 feet apart, and within 20 feet of either side of a roadway, and within 10 linear feet of any fiber optics termination point. The County agency shall reserve sole determination whether spacing of pull boxes shall be less or more than the standard 1,000 feet apart.
5. Relocation of Pull and Splice Boxes:
 - a. Relocation of pull and splice boxes shall consist of removing an existing box and installing the box at the location shown in the Plans. Restore the area of the box removal and relocation to the condition of the adjacent area. The costs for restoration will be included in the Contract unit price of the relocation.
 - b. Boxes damaged due to the Contractor's operations must be replaced by the Contractor at no cost to the County. Replacement boxes must be of the same material and size of the existing box, unless directed otherwise by the CCITD.

3.4 FIELD QUALITY CONTROL

A. Installation Testing:

1. General:

- a. Notify the CCITD of cable testing at least 14 calendar days in advance. Submit the testing procedures to the CCITD staff for approval prior to commencement of testing. Perform all tests at 1310 nm and 1550 nm wavelengths, and include the last calibration date of all test equipment with the test parameters set on the equipment in the test documentation. Ensure that the last calibration date of all test equipment is within the last 12 months and that the calibration certificate is maintained in the test equipment case or provided electronically when requested. Test all installed fibers (terminated and un-terminated) using

methods identified in this Section. All tests must be conducted with a launch box.

- b. Fibers containing splices or fibers terminated on both ends must be bidirectionally tested.
 - c. Present the results of the optical time domain reflectometer (OTDR) testing (i.e., traces for each fiber) and a loss table showing details for each splice and termination tested to the CCITD in an approved electronic format. Ensure all OTDR testing complies with the EIA/TIA-455-61 standard.
- 2. OTDR Attenuation Testing: Perform testing on all fibers to ensure that attenuation does not exceed allowable loss (0.35 dB/km for 1310 nm wavelength, 0.25 dB/km for 1550 nm wavelength, plus 0.5 dB for any connectors and 0.1 dB for splices). Repair or replace cable sections exceeding allowable attenuation at no cost to the County.
- 3. OTDR Tracing: Test all fibers with an OTDR at wavelengths of 1310 and 1550 nm.
- 4. Splice Loss Testing: Ensure that the splice loss for a SMF fusion splice does not exceed a maximum bidirectional average of 0.1 dB per splice when measured using an OTDR. Repair or replace splices that exceed allowable attenuation at no cost to the County.
- 5. Connector Loss Testing: Ensure that the attenuation in the connector at each termination panel and its associated splice does not exceed 0.6 dB when measured using an OTDR. Repair or replace connectors exceeding allowable attenuation at no cost to the County.
- B. Fiber Optic Cable Locator: Locate and mark all existing County owned or maintained fiber optic facilities within project limits prior to performing any subsurface work. Locate and mark as necessary to ensure that all fiber optic facilities are located and visibly marked at all times.
- C. Fiber-Optic Cable Warranty: Ensure that the fiber optic cable, the splice enclosures, and terminations have a manufacturer's warranty covering defects for a minimum of two years from the date of final acceptance. Ensure the warranty includes providing replacements, within 10 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the County.
- D. Pull and Splice Box Warranty: Ensure all pull, splice, and junction boxes have a manufacturer's warranty covering defects for a minimum of one year from the date of final acceptance. Ensure the warranty includes providing replacements, within 30 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the County.
- E. Documentation and Closeout

1. Within ten (10) days following successful installation and testing of the fiber-optic communication work, Contractor shall provide the County both printed and electronic copies of as-built network drawings.
2. At minimum, as-builts shall contain:
 - a. Network block diagrams, identifying endpoints for fiber termination, number of fiber strands and cables, and topology layout.
 - b. Updated site plan of each affected installation site identifying location of the IT telecommunications cabinet, in addition to pull boxes and handhole locations at the installation and interconnecting conduit.
 - c. Updated overall site plan identifying the fiber-optic cable installation for the entire project, including all interconnecting segments between installations or other endpoint locations. Overall site plan shall include all pull boxes, splice vaults, handholes, and fiber cable lengths.
 - d. As-built plans shall additionally be provided as converted Google Earth and Visio formats for County use.

END OF SECTION