



GOODLAND PUMP STATION IMPROVEMENTS

Supplemental Technical Specifications – Bid Set

PREPARED BY



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TABLE OF CONTENTS

SUPPLEMENTAL TECHNICAL SPECIFICATIONS

Note: The following technical specifications shall be incorporated into the Contract Documents for the Goodland Pump Station. In addition to these supplemental technical specifications, the Collier County Utility Standards Manual shall apply to this project.

DIVISION 1 – GENERAL REQUIREMENTS

01010	SUMMARY OF WORK
01152	APPLICATION FOR PAYMENT
01153	CHANGE ORDER PROCEDURES
01250	MEASUREMENT AND PAYMENT
01310	CONSTRUCTION PROGRESS SCHEDULES
01340	SHOP DRAWINGS, WORKING DRAWINGS, AND SAMPLES
01370	SCHEDULE OF VALUES
01505	MOBILIZATION
01540	HURRICANE PREPAREDNESS
01600	MATERIAL AND EQUIPMENT
01700	CONTRACT CLOSEOUT
01710	CLEANING
01720	PROJECT RECORD DOCUMENTS
01740	WARRANTIES AND BONDS

DIVISION 11 – EQUIPMENT

11214	VERTICAL TURBINE PUMPS
11220	SUBMERSIBLE MIXER
11224	IN-LINE STATIC MIXER
11241	CHEMICAL FEED SYSTEM
11245	CHEMICAL METERING PUMPS

DIVISION 15 – MECHANICAL

15090	CHEMICAL FEED SYSTEM PIPING

COLLIER COUNTY STANDARD TECHNICAL SPECIFICATIONS

DIVISION 1 - GENERAL REQUIREMENTS

014200	REFERENCES
014500	QUALITY CONTROL
015000	CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
015526	TRAFFIC REGULATION AND PUBLIC SAFETY
015713	TEMPORARY EROSION AND SEDIMENTATION CONTROL FOR CONSTRUCTION ACTIVITIES IMPACTING
016100	LESS THAN ONE ACRE, INCLUDING CONSTRUCTION REQUIRING DEWATERING MATERIAL AND EQUIPMENT
017300	MISCELLANEOUS WORK AND CLEANUP

DIVISION 2 - EXISTING CONDITIONS

020500	CONNECTIONS TO EXISTING SYSTEMS
022100	LINES AND GRADES
022200	PRE-CONSTRUCTION AUDIO-VIDEO RECORDING
022501	LEAKAGE TESTS
024100	DEMOLITION
025400	DISINFECTION

DIVISION 3 - CONCRETE

031100	CONCRETE FORMWORK
032000	CONCRETE REINFORCEMENT
033000	CONCRETE
033500	CONCRETE FINISHING AND CURING

DIVISION 4 – MASONRY

042000	UNIT MASONRY

DIVISION 5 – METALS

050520	BOLTS, WASHERS, ANCHORS, AND EYEBOLTS
055100	LADDERS, STAIRS, AND STAIR NOSINGS
055200	HANDRAILS AND SAFETY CHAINS
055300	GRATING

DIVISION 9 - FINISHES

099000	HIGH PERFORMANCE PAINTS AND COATINGS

DIVISION 23 – MECHANICAL

230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
231113	FACILITY FUEL – OIL PIPING
232300	REFRIGERANT PIPING
233400	HVAC FANS
233700	AIR OUTLETS AND INLETS
238119	SELF-CONTAINED AIR-CONDITIONERS
238126	SPLIT-SYSTEM AIR-CONDITIONERS

DIVISION 26 – ELECTRICAL

260510	GENERAL EQUIPMENT STIPULATIONS
260511	BASIC ELECTRICAL REQUIREMENTS
260513	WIRES AND CABLES
260526	GROUNDING
260529	SUPPORTING DEVICES
260533	RACEWAYS
260535	CABINETS, BOXES, AND FITTINGS
260553	ELECTRICAL IDENTIFICATION
260573	SHORT-CIRCUIT STUDIES
260574	COORDINATION STUDIES
260575	ARC-FLASH HAZARD ANALYSIS
262200	MOTORS
262213	TRANSFORMERS
262416	PANELBOARDS
262726	WIRING DEVICES
262811	CIRCUIT BREAKERS AND FUSIBLE SWITCHES – LOW VOLTAGE
262813	CIRCUIT AND MOTOR DISCONNECTS
262923	VARIABLE FREQUENCY DRIVE UNIT
263213	STANDBY DIESEL GENERATOR SETS
263600	AUTOMATIC TRANSFER SWITCHES
263613	SAFETY SWITCHES AND DISCONNECTS
264113	LIGHTING PROTECTION
264313	SURGE PROTECTION DEVICES
265119	LIGHTING FIXTURES

DIVISION 31 - EARTHWORK

312316	EXCAVATION – EARTH AND ROCK
312319	GROUNDWATER CONTROL FOR OPEN CUT EXCAVATION
312323	BACKFILLING
314000	SHORING, SHEETING AND BRACING

DIVISION 32 - EXTERIOR IMPROVEMENT

320117	PAVEMENT REPAIR AND RESTORATION
321300	SIDEWALKS, DRIVEWAYS AND CURBS
323113	CHAIN LINK FENCING AND GATES
329200	RESTORATION BY SODDING OR SEEDING

DIVISION 33 - UTILITIES

330503	POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS
330504	DUCTILE IRON PIPE (DIP) AND FITTINGS
330518	LAYING AND JOINTING BURIED PIPELINES
330520	PIPE REMOVAL AND ABANDONMENT
331200	WATER VALVES AND APPURTENANCES
331632	PRESTRESSED CONCRETE STORAGE TANK

DIVISION 40 – PROCESS INTEGRATION

406113	BASIC INSTRUMENTATION REQUIREMENTS
406120	CONTROL PANELS
406123	PROGRAMMABLE LOGIC CONTROLLERS
406166	SOFTWARE SERVICES
406350	FIELD TESTING
406700	I/O TABLE
406710	FIELD INSTRUMENTATION SCHEDULE

APPENDIX A – GEOTECHNICAL REPORT

APPENDIX B – COLLIER COUNTY SCADA STANDARDS

SECTION 01010
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 covered under this contract includes but is not limited to the following:

- 1. Demolition and replacement of the existing concrete ground storage tank.
- 2. Replacement of the existing turbine pumps and associated piping.
- 3. Replacement of existing chemical storage and feed systems.
- 4. Installation of a new caustic storage and feed system.
- 5. Demolition and removal of the existing aluminum platform and stairs.
- 6. Installation of a new generator pad and access stairs.
- 7. Relocation of the existing generator and fuel tank.
- 8. Improvement of the existing recirculation piping system and tank drain system.
- 9. Removal and replacement of chain-link fencing and gates.
- 10. Structural improvements to the existing pump building.
- 11. Site improvements, including grading, drainage, and paving as required.
- 12. Installation of new mechanical, electrical, and instrumentation systems as necessary.
- 13. Modifications to existing utilities and connections to accommodate new infrastructure.
- 14. Compliance with all applicable codes, standards, and permitting requirements throughout construction.

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 equipment.
 3. Maintaining the Work area and site in a clean and acceptable manner.
 4. Protection of finished and unfinished Work.
 5. Repair and restoration of Work or existing facilities damaged during construction.
 6. 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.
- 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. 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 5 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

SECTION 01152

APPLICATION FOR PAYMENT

PART 1 – GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Submit Applications for Payment to Engineer in accordance with the schedule established by Conditions of the Contract and herein.

1.02 RELATED REQUIREMENTS

- A. Agreement between Owner and Contractor.
- B. Conditions of the Contract: Progress Payments, Retainage and Final Payment.
- C. Section 01153: Change Order Procedures.
- D. Section 01370: Schedule of Values.
- E. Section 01700: Contract Closeout.

1.03 FORMAT AND DATA REQUIRED

- A. Submit applications in the form required by Owner, in accordance with the example which will be provided by the Engineer, with itemized data typed on 8-1/2-inch x 11-inch white paper continuation sheets.
- B. Provide itemized data on continuation sheet:
 - 1. Format, schedules, line items and values: Those of the Schedule of Values accepted by Engineer.

1.04 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

- A. Application Form:
 - 1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.
 - 2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.
 - 3. Execute certification with signature of a responsible officer of Contract firm.
- B. Continuation Sheets:

1. Fill in total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.
2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored.
 - a. Round off values to nearest dollar, or as specified for Schedule of Values.
3. List each Change Order executed prior to date of submission at the end of the continuation sheets.
 - a. List by Change Order Number, and description, as for an original component item of work.

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

- A. When the Owner or the Engineer requires substantiating data, Contractor shall submit suitable information, with a cover letter identifying:
 1. Project
 2. Application number and date.
 3. Detailed list of enclosures.
 4. For stored products:
 - a. Item number and identification as shown on application.
 - b. Description of specific material.
- B. Submit one copy of data and cover letter for each copy of application.

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT

- A. Fill in Application form as specified for progress payments.
- B. Use continuation sheet for presenting the final statement of accounting as specified in Section 01700-Contract Closeout.

1.07 SUBMITTAL PROCEDURE

- A. Submit Applications for Payment to Engineer at the times stipulated.
- B. Number: 1 electronic copy of each Application.
- C. When Engineer finds Application properly completed and correct, he will transmit certificate for payment to Owner (the Clerk of Courts), with copy to Contractor.

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

END OF SECTION

SECTION 01153

CHANGE ORDER PROCEDURES

PART 1 – GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Promptly implement change order procedures.
 - 1. Provide full written data required to evaluate changes.
 - 2. Maintain detailed records of work done on a time and material/force account basis.
 - 3. Provide full documentation to Engineer on request.
- B. Designate in writing the member of Contractor's organization:
 - 1. Who is authorized to accept changes in the Work.
 - 2. Who is responsible for informing others in the Contractor's employ of the authorization of changes in the Work.
- C. Owner will designate in writing the person who is authorized to execute change Orders.

1.02 RELATED REQUIREMENTS

- A. Section 01152: Application for Payment.
- B. Section 01310: Construction Schedules.
- C. Section 01370: Schedule of Values.
- D. Section 01700: Contract Closeout.

1.03 DEFINITIONS

- A. Change Order: See General Conditions.
- B. Work Directive: A written order to the Contractor, signed by Owner and Engineer, which amends the Contract Documents as described, and authorizes Contractor to proceed with a change which affects the Contract Sum or the Contract Time, for inclusion in a subsequent Change Order.
- C. Field Order: A written order, instructions, or interpretations, signed by Engineer making minor changes in the Work not involving a change in Contract Sum or Contract Time.

1.04 PRELIMINARY PROCEDURES

- A. Owner or Engineer may initiate changes by submitting a Proposal Request to Contractor. Request will include:
 - 1. Detailed description of the change, products, and location of the change in the Project.
 - 2. Supplementary or revised Drawings and Specifications.
 - 3. The projected time span for making the change, and a specific statement as to whether overtime work is, or is not, authorized.
 - 4. A specific period of time during which the requested price will be considered valid.
 - 5. Such request is for information only, and is not an instruction to execute the changes, nor to stop Work in progress.
- B. Contractor may initiate changes by submitting a written notice to Engineer, containing:
 - 1. Description of the proposed changes.
 - 2. Statement of the reason for making the changes.
 - 3. Statement of the effect on the Contract Sum and the Contract Time.
 - 4. Statement of the effect on the work of separate contractors.
 - 5. Documentation supporting any change in Contract Sum or Contract Time, as appropriate.

1.05 Work Directive

- A. In lieu of Proposal Request, Engineer may issue a work directive for Contractor to proceed with a change for subsequent inclusion in a Change Order.
- B. Directive will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change and will designate the method of determining any change in the Contract Sum and any change in Contract Time.
- C. Owner and Engineer will sign and date the Work Directive as authorization for the Contractor to proceed with the changes.

1.06 DOCUMENTATION OF PROPOSALS AND CLAIMS

- A. Support each quotation for time and material price proposals, with sufficient substantiating data to allow Engineer to evaluate the quotation.
- B. On request provide additional data to support time and cost computations:
 - 1. Labor required.
 - 2. Equipment required.

3. Products required.
 - a. Recommended sources of purchase and unit cost.
 - b. Quantities required.
4. Taxes, insurance and bonds.
5. Credit for work deleted from Contract, similarly documented.
6. Overhead and profit.
7. Justification for any change in Contract Time.
- C. Support each claim for additional costs, and for work done on a time-and-material basis, with documentation as required, with additional information:
 1. Name of Owner's authorized agent who ordered the work, and date of the order.
 2. Dates and times work was performed, and by whom.
 3. Time record, summary of hours worked, and hourly rates paid.
 4. Receipts and invoices for:
 - a. Equipment used, listing dates and times of use.
 - b. Products used, listing of quantities.
 - c. Subcontractors.
- D. Document requests for substitutions for Products as specified in Section 01630.

1.07 PREPARATION OF CHANGE ORDERS

- A. Owner will prepare each Change Order.
- B. Owner's Form, per example provided by the Engineer.
- C. Change Order will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.
- D. Change Order will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.

1.8 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/CONSTRUCTION CHANGE AUTHORIZATION

- A. Engineer and Owner will issue a Construction Change Authorization directing Contractor to proceed with the changes.

- B. At completion of the change, Contractor shall submit itemized accounting and supporting data as provided in the Article "Documentation of Proposals and Claims" of this Section.
- C. Engineer will determine the allowable cost of such work, as provided in General Conditions.
- D. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.
- E. Owner and Contractor will sign and date the Change Order to indicate their agreement therewith.

1.9 CORRELATION WITH CONTRACTOR'S SUBMITTALS

- A. Periodically revise Schedule of Values and Request for Payment forms to record each change as a separate item of Work, and to record the adjusted Contract Sum.
- B. Periodically revise the Construction Schedule to reflect each change in Contract Time.
 - 1. Revise subschedules to show changes for other items of work affected by the changes.
- C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01250

MEASUREMENT AND PAYMENT

PART 1- GENERAL

1.01 DESCRIPTION

- A. This section describes the method used to determine quantities of Work performed or materials supplied for which a price is given in the Bid. It establishes the basis upon which payment will be made for Payment Items.
- B. Subject to the provisions in General Conditions, all Work and payment for the Work is represented by Payment Items and associated unit prices.

1.02 PAYMENT

- A. Subject to all other contract requirements, the Contractor shall be paid for "as-built" quantities of Work for which a price is given in the bid.
- B. Quantities on the Bid Form are for comparison in competitive bidding only and do not constitute the basis for payment or measurement of quantities.
- C. Quantities on the Bid Form are estimated and may be increased or decreased without limit.
- D. No separate payment will be made for one Payment Item as Work incidentally required to complete the Work of another.
- E. Payment for Work performed shall be made in accordance with the unit prices in the Bid. Retainage shall apply to all Contractor payments prior to final acceptance.

1.03 MEASUREMENT FOR PAYMENT

- A. Methods of Measurement:
 - 1. Measurements of lengths, widths, slope angles, and depths or elevations shall be made to determine "as-built" quantities of lengths, areas and volumes pertinent to Payment Items.
 - a. Unless otherwise specified, all lengths shall be horizontal distances.
 - b. Slope angles and elevations shall be measured using land surveying equipment.

2. Graphic representations of measured quantities shall be drafted to scale using the Drawings where convenient and appropriate. Additional drawings shall be drafted if required.
 - a. Irregular shapes representing areas and volumes shall be measured using a compensating polar planimeter or a computer digitizer.
 - b. Regular shapes shall be scaled.
3. Use of Drawings:
 - a. Unless otherwise agreed upon between the Contractor and Owner, the Drawings shall be used as the basis to establish existing grades and other existing topographic features.

B. Payment limits where Payment Lines are not shown on the Drawings:

1. Pipe Length: Measurement of pipe shall be made along the top of pipe, excluding fittings, valves and manholes, in place, taken as the laying length.
2. Except as specified otherwise, measurements of Payment Item quantities of weights, lengths, areas and volumes shall be made:
 - a. On "as-built" and in-place completed Work, during construction or at the time of Substantial Completion.
 - b. If no other feasible and practical methods of measurements are available, by delivery slips delivered to the Engineer.
3. Adjustments shall be made to eliminate overlaps in area and volume measurements.

1.04 PAYMENT ITEMS

- A. Separate payment will be made for the Unit Price and Lump Sum items listed on the Bid Form. Related work not specifically listed or identified below in 1.04 B and C, but evidently necessary for satisfactory completion of the Item shall be considered to be included.
- B. No separate payment will be made for the following Work, and its cost shall be included in the Bid Price of the Payment Item to which it is associated:
 1. Trench excavation, sheeting, shoring and bracing.
 2. Cleanup.
 3. Testing, including all materials and equipment.
 4. Maintenance of utility service.
 5. Appurtenant work.
 6. Record Drawings.

7. Field Office.
8. Saw cutting.
9. Coordination with other contractors.
10. Layout of the work.
11. Notifications to property owners of construction schedule and service interruptions.
12. Restoration and Sodding
13. Dewatering
14. Rock Removal

C. Measurement and Payment Items as listed in the Bid Schedule:

1. Mobilization/Demobilization

- A. No measurement shall be made for this item.
- B. Payment of Mobilization/Demobilization will be made at the Bid Form lump sum price, which will be full compensation for all preparatory Work and operations in mobilizing for beginning work on the Project and demobilizing for ending work on the Project; establishment of field offices, buildings, safety equipment, first aid supplies, sanitary and other facilities, as required by these Specifications, State and local laws and any other preconstruction expense necessary for the state of the Work; the cost of field engineering, including permits and fees, construction schedules, shop drawings, temporary facilities, lay down storage area, construction aids, reviews and inspection, re-inspection and any rework resulting from same, cleaning, contractor red-lined drawings, operating and maintenance data. The Contractor shall submit invoices substantiating the cost of mobilization with each pay request. Payment for mobilization / demobilization shall be as follows: 75% shall be paid at the time of first invoice after the Contractor has mobilized to the site and established field operations. The remaining 25% shall be paid at the completion of the project when the contractor has properly demobilized, cleaned the site, and completed all restoration.

2. General Requirements

- A. Measurement for General Requirement will be on a lump sum basis.
- B. Payment for General Requirement will be made at the Bid Form lump sum price, which will be full compensation for all preparatory work, surveying, silt barriers, and inlet protection, field staking of Right-of-Way adjacent to proposed work areas prior to the start of construction in coordination with public outreach and notification, operations necessary for the movement of personnel, establishment of temporary facilities, cost of bonds, permits, required insurance labor, materials, and equipment necessary to provide maintenance of traffic items. Contractor shall be paid in equal monthly amounts based on the scheduled duration of the project from Notice to Proceed to Substantial Completion.

3. Restoration

- A. Measurement of Restoration will be made on a lump sum basis.
- B. Payment for Restoration will be made at the Contract lump sum price for the item, which price and payment shall be full compensation for all restoration work associated with the open cut installation of yard piping and other works shown in the plans, including but not limited to the restoration of swales, lawn areas, grass (to match the existing pre-construction type), landscaping, signs, markers, mailboxes, seeding and mulching, fences, curbing, sprinklers, drainage pipes including concrete, metal, and plastic pipe, drainage structures including inlets, mitered end sections and headwalls and other appurtenances, replacement of guardrails and concrete retaining walls, filling and final grading of all areas within the project, final grading of disturbed areas (to provide positive drainage), removal of trees, bushes and other vegetation, hauling, watering, fertilizing, all labor, materials, equipment, and other incidentals necessary to complete the item.

4. Demolition

- A. Measurement of Demolition will be made on a lump sum basis.
- B. Payment for Demolition will be made at the Contract lump sum for the item, which price and payment shall be full compensation for all demolition work associated with the project, including removal/disposal and any permitting fees associated with off-site disposal. This shall include but not be limited to the removal of existing asphalt driveway, cutting and removal of existing yard piping and fittings, recirculation assembly, platforms, structures, bollards, slabs, subgrades, relocation of the generator and fuel tank, existing pumps and associated piping, existing chemical storage and feed system, and electrical/mechanical components proposed for removal. Costs for protection of existing equipment and surrounding facilities during demolition shall also be included within this item.

5. Asphalt Driveway

- A. Measurement for Asphalt Driveway will be made on a lump sum basis.
- B. Payment for Asphalt Driveway will be made at the Contract lump sum price for the item, which price and payment shall be full compensation for all labor, materials, and equipment, asphalt to complete the work, including but not limited to demolition of the existing driveway, re-compaction of existing base, mill and overlay, saw cutting (as necessary), finishing, grading, and any other incidentals complete the installation.

6. Yard Piping

- A. Measurement of Yard Piping will made on a lump sum basis.
- B. Payment for Yard Piping will be made at the Contract lump sum price for the item, which price and payment shall be full compensation for all labor, materials, tools, and equipment services required. Payment shall be full compensation for the cost to complete all excavation, rock removal, dewatering; installation of all underground piping, fittings, restraints, sleeves, valve extension, valve boxes, blind flanges, and all other items necessary to complete the installation as shown on the Drawings and specified herein. Payment will be based on percentage of work complete during the pay period at time of pay application to the nearest 10% complete. The cumulative total shall not exceed the Lump Sum Bid Pay Item amount.

7. Recirculation Pump Assembly

- A. Measurement of Recirculation Pump Assembly will made on a lump sum basis.
- B. Payment for Recirculation Pump Assembly will be made at the Contract lump sum price for the item, which price and payment shall be full compensation for all labor, materials, tools, and equipment services required. Payment shall be full compensation for the cost of all excavation, rock removal, dewatering; installation of pipes, fittings, restraints, sleeves, valves, valve extension, valve boxes, blind flanges, flow meters, static mixers, ARVs, the recirculation pump and pump can, the chemical injection quills, and all other items necessary to complete the installation of the tank recirculation system as shown on the project plans and specified herein.

8. Tank Drain Assembly

- A. Measurement of Tank Drain Assembly will made on a lump sum basis.
- B. Payment for Tank Drain Assembly will be made at the Contract lump sum price for the item, which price and payment shall be full compensation for all labor, materials, tools, and equipment services required. Payment shall be full compensation for the cost for all excavation, rock removal, dewatering; installation of pipes, fittings, restraints, sleeves, valves, riprap, and all other items necessary to complete the installation of the tank drain assembly as shown on the project plans and specified herein.

9. Pump Building Interior Piping Assembly

- A. Measurement for Pump Building Interior Piping Assembly will be made on a lump sum basis.

- B. Payment for Pump Building Interior Piping Assembly include the cost of all labor, equipment, materials, and services necessary for the demolition of existing piping and pipe support; installation of new piping, fittings, valves, coatings, restrained joint piping, and all other items as shown in the Drawings.

10. Vertical Turbine Pumps

- A. Measurement for Vertical Turbine Pumps will be made on a lump sum basis.
- B. Payment for Vertical Turbine Pump will be made at the Bid Form unit price per each pump installed, which price and payment shall be full compensation for all labor, equipment, materials, and services necessary for the installation of the vertical turbine pumps, including but not limited to the turbine pumps, piping, valves, and other process components necessary. All modifications to the openings in the pump room floor, connection to the ductile iron piping below the building, All stainless-steel hardware, coatings, fittings, pipe supports, restrained joint piping, and any other specific components or materials required for the installation of the vertical turbine pumps as specified in the project plans and these specifications.

11. Sodium Hypochlorite Pump Skid and Chemical Storage

- A. Measurement for Sodium Hypochlorite Pump Skid and Chemical Storage will be made on a lump sum basis.
- B. Payment for Sodium Hypochlorite Pump Skid and Chemical Storage include the cost of all labor, equipment, materials, and services necessary for the demolition and removal of existing sodium hypochlorite storage and feed system, including all pumps, piping, storage tank, valves, and ancillary components as shown in the project plans. Payment shall also include the cost for installation of new chemical pump skids, piping and pipe support; chemical storage tank, fittings, valves, coatings, restrained joint piping, containment walls, emergency eye wash and shower, and all other items as shown in the project plans.

12. Caustic Pump Skid and Chemical Storage

- A. Measurement for Caustic Pump Skid and Chemical Storage will be made on a lump sum basis.
- B. Payment for Caustic Pump Skid and Chemical Storage include the cost of all labor, equipment, materials, and services necessary for the caustic storage and feed system. Payment shall include the cost for installation of new chemical pump skids, piping and pipe support; chemical storage tank, fittings,

valves, coatings, restrained joint piping, containment walls, emergency eye wash and shower, and all other items as shown in the project plans.

13. Generator

- A. Measurement for Generator will be made on a lump sum basis.
- B. Payment for Generator will be made on a lump sum basis, which price and payment shall be full compensation for all labor, equipment, materials, and services necessary for the relocation of the generator, including but not limited to include the cost of all labor, equipment, materials, and services necessary for the handling, installation and connection of the generator, and all other work as shown in the project plans.

14. Fuel System Improvements

- A. Measurement for the Fuel System Improvements will be made on a lump sum basis.
- B. Payment for Fuel System Improvements will be made on a lump sum basis, which price and payment shall be full compensation for all labor, equipment, materials, and services necessary for the relocation of the fuel system, including but not limited to include the cost of all labor, equipment, materials, and services necessary for the handling, installation and connection of the fuel storage tank, feed piping, on-site tightness testing of the tank, all FDEP reporting and permitting that is required for the registered tank, and all other work as shown in the project plans.

15. Mechanical HVAC Improvements

- A. Measurement for Mechanical HVAC Improvements will be made on a lump sum basis.
- B. Payment for Mechanical HVAC Improvements shall include all labor, equipment, materials, and services necessary for the improvements of the HVAC system, including but not limited to thermostats, air handling units, condensation drainage pipe, condensation drywell, pipe support, and any other specific components or materials required for the completion of the mechanical work as specified in the project plans and these specifications.

16. Electrical Improvements

- A. Measurement for Electrical Improvements will be made on a lump sum basis.
- B. Payment for Electrical Improvements shall include all labor, equipment, materials, and services necessary for the improvements of the electrical

components, including but not limited to installation of control panels, electrical hardware, electrical connections, wires, conduits, VFDs, switches, breakers, wiring, transformer, light fixtures, batteries, and any other specific components or materials required for the completion of the electrical work at the pump station as specified in the project plans and these specifications.

17. Structural Improvements

- A. Measurement for Structural Improvements will be made on a lump sum basis.
- B. Payment for Structural improvements shall include all labor, equipment, materials, and services necessary for the upgrades of the structural items, including but not limited to all excavation (including rock excavation), disposal of excess excavated materials, generator slab and stairs, concrete slabs for aboveground piping, formwork, shoring, sheeting and bracing, backfill, and any other specific components or materials required for the construction as specified in the project plans and these specifications.

18. 500,000 Gallon Ground Storage Tank

- A. Measurement for 500,000 Gallon Ground Storage Tank will be made on a lump sum basis.
- B. Payment for 500,000 Gallon Ground Storage Tank shall include all labor, materials, equipment, tools, and incidental work necessary to remove and replace the existing 500,000-gallon ground storage tank with a new prestressed concrete ground storage tank (GST), complete and in place, in accordance with the Contract Documents, plans, and specifications. The scope of work under this bid item shall include, but is not limited to, the following:
 - Demolition, removal, and proper disposal of the existing 500,000-gallon ground storage tank and associated appurtenances.
 - Design, fabrication, and installation of a new prestressed concrete ground storage tank with a nominal capacity of 500,000 gallons.
 - Construction of a new reinforced concrete pile foundation system to support the new tank, including driving of concrete piles and construction of the tank foundation slab and ring wall.
 - Evaluation and modification of the existing timber pile foundation system, if required, to accommodate the new tank structure and ensure long-term stability and performance.
 - Installation of all necessary piping connections into and out of the tank, including inlet, outlet, overflow, drain, and any appurtenances or access provisions shown or specified.

- Associated site work including excavation, grading, backfilling, compaction, drainage, and surface restoration as necessary to facilitate construction of the new tank.
- Protection or rerouting of existing utilities as required to accommodate the new work.
- Testing, disinfection, and commissioning of the new tank per applicable regulatory and project requirements.
- Compliance with all relevant codes, regulations, and permit conditions.

Payment for this item shall be made at the lump sum price bid for "500000 Gallon Concrete Ground Storage Tank" and shall constitute full compensation for all labor, materials, equipment, tools, supervision, testing, and incidentals necessary to complete the work as specified. No additional payment will be made for demolition, foundation work, piping, site preparation, or any other associated tasks unless otherwise specified under a separate bid item.

19. Bypass Operations

- A. Measurement for Bypass Operations will be made on a lump sum basis.
- B. Payment for Bypass Operations shall include all labor, equipment, materials, and services necessary for the bypass operation to ensure the non-stop service at this pump station, including but not limited to all bypass piping, valves, temporary pumps, line stops, chemical feeding systems, and any other specific components or materials required for the bypass operation as specified in the project plans and these specifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01310
CONSTRUCTION SCHEDULES

PART 1 – GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Promptly after award of the Contract, prepare and submit to Engineer estimated construction progress schedules for the Work, with subschedules of related activities which are essential to it progress.
- B. Submit revised progress schedules to maintain proposed schedule within 30 days of work in place.

1.02 RELATED REQUIREMENTS

- A. Section 01010: Summary of Work.
- B. Section 01041: Project Coordination.
- C. Section 01200: Project Meetings.
- D. Section 01340: Shop Drawings, Product Data and Samples.

1.03 FORM OF SCHEDULES

- A. Prepare schedules in the form of:
 - 1. Gant Chart.
 - 2. Network Analysis System.
 - 3. Other Method Accepted by Engineer.
- B. Format of Listings: The chronological order of the start of each item of work.

1.04 CONTENT OF SCHEDULES

- A. Construction Progress Schedule:
 - 1. Show the complete sequence of construction by activity.

2. Show the dates for the beginning, and completion of each major element of construction. Specifically list:
 - a. Site work.
 - b. Site utilities.
 - c. Subcontractor work.
 - d. Equipment installations.
 - e. Operating and Maintenance Data.
 - f. Start-up.
- B. Submittals, Schedule for Shop Drawings, Product Data and Samples. Show:
 1. The dates for Contractor's submittals.
 2. The dates reviewed submittals will be required from the Engineer.
 3. Provide subschedules to define critical portions of prime schedules.

1.05 PROGRESS REVISIONS

- A. Indicate progress of each activity to date of submission.
- B. Show changes occurring since previous submission of schedule:
 1. Major change in scope.
 2. Activities modified since previous submission.
 3. Revised projections of progress and completion.
 4. Other identifiable changes.
- C. Provide a narrative report as needed to define:
 1. Problem areas, anticipated delays, and the impact on the schedule.
 2. Corrective action recommended, and its effect.
 3. The effect of changes on schedules of other prime contractors.

1.06 SUBMISSIONS

- A. Submit initial schedules within 10 days after the effective date of the Agreement.

1. Engineer will review schedules and return review copy within 10 days after receipt.
 2. If required, resubmit within seven days after return of review copy.
- B. With each application for payment, submit progress schedule if revised since last payment request.

1.07 DISTRIBUTION

- A. Distribute copies of the reviewed schedules to:
1. Engineer – Two (2) copies
 2. Owner – Two (2) copies
 3. Job site file.
 4. Subcontractors.
 5. Other concerned parties.
- B. Instruct recipients to report promptly to the Contractor, in writing, any problems anticipated by the projections shown in the schedules.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01340

SHOP DRAWINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. The Contractor shall submit to the Engineer for review and approval, such Shop Drawings, Test Reports and Product Data on materials and equipment (hereinafter in this Section called Data), and material samples (hereinafter in this Section called Samples) as are required for the proper control of work, including but not limited to those Shop Drawings, Data and Samples for materials and equipment specified elsewhere in the Specifications and in the Contract Drawings.
2. Within fourteen (14) calendar days after the Notice to Proceed date, the Contractor shall submit to the Engineer a complete list of preliminary Data on items for which Shop Drawings are to be submitted. Included in this list shall be the names of all proposed manufacturers furnishing specified items. Review of this list by the Engineer shall in no way expressed or implied relieve the Contractor from submitting complete Shop Drawings and providing materials, equipment, etc., fully in accordance with the Specifications. This procedure is required in order to expedite final review of Shop Drawings. The Contractor shall include Shop Drawing review time on the Project schedule (see section 01310).
3. The Contractor is to maintain an accurate updated submittal log and will bring this log to each scheduled progress meeting with the Owner and the Engineer. This log should include the following items:
 - a. Submittal-Description and Number assigned.
 - b. Date to Engineer.
 - c. Date returned to Contractor.
 - d. Status of Submittal (Approved as Noted, Rejected/Re-submit).
 - e. Date of Resubmittal and Return (as applicable).
 - f. Date material release for fabrication.
 - g. Projected date of fabrication.
 - h. Projected date of delivery to site.

- i. Status of O&M manuals submittal.
 - j. Specification Section.
 - k. Drawings Sheet Number.
- B. Related Requirements Described Elsewhere:
 - 1. General Conditions.
 - 2. Progress Schedules: Section 01310.
 - 3. Material and Equipment: Section 01600.
 - 4. Project Record Documents: Section 01720.

1.02 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall furnish the Engineer a schedule of Shop Drawings submittals fixing the respective dates for the submission of Shop Drawings, the beginning of manufacture, testing and installation of materials, supplies and equipment. This schedule shall indicate those that are critical to the progress schedule.
- B. The Contractor shall not begin any of the work covered by a Shop Drawing, Data, or a Sample returned for correction until a revision or correction thereof has been reviewed and returned to him, by the Engineer, with approval.
- C. The Contractor shall submit to the Engineer all drawings and schedules sufficiently in advance of construction requirements to provide no less than thirty (30) calendar days for checking and appropriate action from the time the Engineer receives them.
- D. All submittals shall be accompanied with a transmittal letter prepared in duplicate containing the following information:
 - 1. Date.
 - 2. Project Title and Number.
 - 3. Contractor's name and address.
 - 4. The number of each Shop Drawings, Project Data, and Sample submitted.

5. Notification of Deviations from Contract Documents.
 - a. The Contractor shall indicate in **bold type** at the top of the cover sheet of submittal of Shop Drawing if there is a deviation from Contract Drawings, Project Specifications and referenced specifications or codes.
 - b. The Contractor shall also list any deviations from Contract Drawings, Project Specifications and referenced specifications or codes and identify in "green" ink prominently on the drawings.
 6. Submittal Log Number conforming to Specification Log Number.
- E. The Contractor shall submit all shop drawings in electronic format. Shop drawings which require the signature and seal of a registered professional shall be submitted in hard copy format. In addition to electronic submittals, the contractor may be required to submit additional hard copies of all submittals upon request from the Owner or the Engineer.
 - F. The Contractor shall be responsible for and bear all costs of damages which may result from the ordering of any material or from proceeding with any part of work prior to the completion of the review by the Engineer of the necessary Shop Drawings.
 - G. The Contractor shall be fully responsible for observing the need for and making any changes in the arrangement of piping equipment, connections, wiring, manner of installation, etc., which may be required by the materials/equipment he proposed to supply both as pertains to his own work and any work affected under other parts, headings, or divisions of drawings and specifications.
 - H. The Contractor shall not use Shop Drawings as means of proposing alternate items to demonstrate compliance to Contract requirements.
 - I. Each submittal will bear a stamp indicating that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.
 - J. Drawings and schedules shall be checked and coordinated with the work of all trades and sub-contractors involved, before they are submitted for review by the Engineer and shall bear the Contractor's stamp of approval as evidence of such checking and coordination. Drawings or schedules submitted without this stamp of approval shall be returned to the Contractor for resubmission.

1.03 ENGINEER'S REVIEW OF SHOP DRAWINGS

- A. The Engineer's review of Shop Drawings, Data and Samples as submitted by the Contractor, will be to determine if the items(s) conform to the information in the Contract Documents and are compatible with the design concept. The Engineer's review and exceptions, if any, will not constitute an approval of dimensions, connections, quantities, and details of the material, equipment, device, or item shown.
- B. The review of drawings and schedules will be general, and shall not be construed:
 - 1. As permitting any departure from the Contract requirements.
 - 2. As relieving the Contractor of responsibility for any errors, including details, dimensions, and materials.
 - 3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.
- C. If the drawings or schedules as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting an exception.
- D. "Approved as Noted" - Contractor shall incorporate Engineer's comments into the submittal before release to manufacturer. The Contractor shall send a letter to the Engineer acknowledging the comments and their incorporation into the Shop Drawing.
- E. "Amend and Resubmit" - Contractor shall resubmit the Shop Drawing to the Engineer. The resubmittal shall incorporate the Engineer's comments highlighted on the Shop Drawing.
- F. "Rejected" - Contractor shall resubmit Shop Drawing for review by Engineer.
- G. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, to revisions other than the corrections requested by the Engineer on previous submissions. The Contractor shall make any corrections required by the Engineer.
- H. If the Contractor considers any correction indicated on the drawings to constitute a change to the Contract Drawings or Specifications, the Contractor shall give written notice thereof to the Engineer.
- I. When the Shop Drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

- J. No partial submittals will be reviewed. Submittals not deemed complete will be stamped "Rejected" and returned to the Contractor for resubmittal. Unless otherwise specifically permitted by the Engineer, make all submittals in groups containing all associated items for:

1. Systems.
2. Processes.
3. As indicated in specific Specifications Sections.

All drawings, schematics, manufacturer's product Data, certifications and other Shop Drawing submittals required by a system specification shall be submitted at one time as a package to facilitate interface checking.

- K. Only the Engineer shall utilize the color "red" in marking Shop Drawing submittals.

1.04 SHOP DRAWINGS

- A. Shop Drawings shall be complete and detailed and shall consist of fabrication, erection and setting drawings and schedule drawings, manufacturer's scale drawings, and wiring and control diagrams. Cuts, catalogs, pamphlets, descriptive literature, and performance and test data, shall be considered only as supportive information. As used herein, the term "manufactured" applies to standard units usually mass-produced; and "fabricated" means items specifically assembled or made out of selected materials to meet individual design requirements.
- B. Manufacturer's catalog sheets, brochures, diagrams, illustrations and other standard descriptive data shall be clearly marked to identify pertinent materials, product or models. Delete information which is not applicable to the Work by striking or cross-hatching.
- C. Each Shop Drawing shall have a blank area 3-1/2 inches by 3-1/2 inches, located adjacent to the title block. The title block shall display the following:
1. Project Title and Number.
 2. Name of Project building or structure.
 3. Number and title of the Shop Drawing.
 4. Date of Shop Drawing or revision.
 5. Name of contractor and subcontractor submitting drawing.
 6. Supplier/manufacturer.
 7. Separate details when pertinent.

8. Specification title and number.

9. Specification section.

10. Application Contract Drawing Number.

D. Data on materials and equipment include, without limitation, materials and equipment lists, catalog data sheets, cuts, performance curves, diagrams, materials of construction and similar descriptive material. Materials and equipment lists shall give, for each item thereon, the name and location of the supplier or manufacturer, trade name, catalog reference, size, finish and all other pertinent Data.

E. For all mechanical and electrical equipment furnished, the Contractor shall provide a list including the equipment name, and address and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained.

1.05 WORKING DRAWINGS

A. When used in the Contract Documents, the term "Working Drawings" shall be considered to mean the Contractor's plan for temporary structures such as temporary bulkheads, support of open cut excavation, support of utilities, ground water control systems, forming and falsework; for underpinning; and for such other work as may be required for construction but does not become an integral part of the Project.

B. Working Drawings shall be signed by a registered Professional Engineer, currently licensed to practice in the State of Florida.

1.06 SAMPLES

A. The Contractor shall furnish, for the approval of the Engineer, samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed. The Contractor shall prepay all shipping charges on samples. Materials or equipment for which samples are required shall not be used in work until approved by the Engineer.

B. Samples shall be of sufficient size and quantity to clearly illustrate:

1. Functional characteristics of the product, with integrally related parts and attachment devices.

2. Full range of color, texture and pattern.

3. A minimum of two (2) samples of each item shall be submitted.

C. Each sample shall have a label indicating:

1. Name of Project.
2. Name of Contractor and Subcontractor.
3. Material or Equipment Represented.
4. Place of Origin.
5. Name of Producer and Brand (if any).
6. Location in Project.

Samples of finished materials shall have additional marking that will identify them under the finished schedules.

- D. The Contractor shall prepare a transmittal letter in triplicate for each shipment of samples containing the information required in Paragraph 1.06B. above. He shall enclose a copy of this letter with the shipment and send a copy of this letter to the Engineer. Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any Contract requirements.
- E. Approved samples not destroyed in testing shall be sent to the Engineer or stored at the site of the Work. Approved Samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the approved Samples. Samples which failed testing or were not approved will be returned to the Contractor at his expense, if so requested at time of submission.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01370
SCHEDULE OF VALUES

PART 1 – GENERAL

1.01 REQUIREMENTS INCLUDED

- A. As the first shop drawing submittal, submit to the Engineer a Schedule of Values allocated to the various portions of the Work, within ten days after award of contract.
- B. Upon the request of the Engineer, support the values with data which will substantiate their correctness.
- C. The Schedule of Values, unless objected to by the Engineer, shall be exclusively used as the basis for the Contractor's Applications for Payment.

1.02 RELATED REQUIREMENTS

- A. Section 01152: Application for Payment.
- B. Section 01600: Material and Equipment.

1.03 FORM AND CONTENT OF SCHEDULE OF VALUES

- A. Type schedule on 8-1/2 inch x 11-inch white paper; Contractor's standard forms and automated printout will be considered for approval by Engineer upon Contractors request. Identify schedule with:
 - 1. Title of Project, location and (City, County, Owner) Project Number.
 - 2. Engineer and Engineer's Project Number.
 - 3. Name and Address of Contractor.
 - 4. Date of Submission.
- B. Schedule shall list the installed value of the component parts of the Work, in sufficient detail to serve as a basis for computing values for progress payments during construction.
- C. Follow the table of contents of these Specifications as the format for listing component items.
 - 1. Identify each line item with the number and title of the respective major section of the specifications.
- D. For each major line item list sub-values of:

1. Major products or operations under the item.
 2. Contract conditions, such as: bonds, insurance premiums, job mobilization, construction facilities and temporary controls.
- E. For the various portions of the Work:
1. Each item shall include a directly proportional amount of the Contractor's overhead and profit.
 2. For items on which progress payments will be requested for stored materials, break down the value into:
 - a. The cost of the materials, delivered and unloaded, with taxes paid.
 - b. The total installed value.
- F. The sum of all values listed in the schedule shall equal the total Contract Sum.

1.04 SUBSCHEDULE OF UNIT MATERIAL VALUES

- A. Submit a subschedule of unit costs and quantities for:
1. Products specified under a unit cost.
 2. Products on which progress payments will be requested for stored products.
- B. The form of submittal shall parallel that of the Schedule of Values, with each item identified the same as the line item in the Schedule of Values.
- C. The unit quantity for bulk materials shall include an allowance for normal waste.
- D. The unit values for the materials shall be broken down into:
1. Cost of the material, delivered and unloaded at the site, with taxes paid.
 2. Installation costs, including Contractor's overhead and profit.
- E. The installed unit value multiplied by the quantity listed shall equal the cost of that item in the schedule of Values.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01505

MOBILIZATION

PART 1 -- GENERAL

1.1 GENERAL

- A. Mobilization shall include the obtaining of all permits; moving onto the site of all necessary equipment; furnishing and erecting temporary buildings and other construction facilities; and implementing security requirements; all as required for the proper performance and completion of the Work. Mobilization shall include the following principal items:
1. Mobilize to the site of all Contractor's equipment, personnel, supplies, and incidentals required for first month's operations.
 2. Project sign in accordance with Section 01580, if required.
 3. On-site sanitary facilities, safety equipment, and first aid supplies.
 4. Arrange for Work and storage yard in accordance with Section 01550.
 5. Mobilize full-time superintendent to the job site.
 6. Detailed approved schedule in accordance with Section 01310.
 7. Required submittals which allow the Contractor to commence Work.
 8. All required permits, insurance, bonds and licenses to commence Work.
 8. Post all OSHA, MSDS, SRF and NPDES required notices.
 9. Safety Plan.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

END OF SECTION

SECTION 01540

HURRICANE PREPAREDNESS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The Contractor is responsible for having plans for protection of the WORK site during hurricanes and shall prepare and submit a Hurricane Preparedness Plan prior to any construction activity and mobilization.
- B. The Hurricane Preparedness Plan shall be submitted to the Owner at the Preconstruction Meeting for approval and shall include the following:
 - 1. Items and equipment that must be removed from the WORK site.
 - 2. Methods and materials that will be utilized to secure the materials and WORK site.
 - 3. Methods and materials that will be utilized to protect uncompleted WORK items.
 - 4. Plan for maximizing traffic lanes for evacuation.
 - 5. Items that must commence at the time of hurricane watch in order to be completed prior to evacuation.
- C. When the National Weather Service issues a Hurricane Watch for Lee, Charlotte, or Collier County, the Contractor shall immediately implement the Hurricane Preparedness Plan.
- D. The cost of preparing and implementing the Hurricane Preparedness Plan shall be the responsibility of the Contractor. Hurricane watch and warning will be grounds for contract time extensions.
- E. When the National Weather Service issues a Hurricane Warning for Lee, Charlotte, or Collier County, the Contractor shall immediately take down and securely store all project signs. Signs shall be restored to the site prior to commencing construction activities.
- F. The Contractor shall notify the Owner upon activation of the hurricane preparedness plan, when preparations are complete, when the job site is secure, and when the job site is shut down.

1.2 CONTRACTOR SUBMITTALS

- A. Submittals of the Hurricane Preparedness Plan shall be in accordance with Section 01300 Contractor Submittals.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 – GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Products.
- B. Workmanship.
- C. Manufacturer's Instructions.
- D. Transportation and Handling.
- E. Storage and Protection.

1.02 RELATED REQUIREMENTS

- A. Section 01010: Summary of Work.
- B. Section 01090: Reference Standards.
- C. Section 01340: Shop Drawings, Product Data and Samples.
- D. Section 01700: Contract Closeout.

1.03 PRODUCTS

- A. Products include material, equipment, and systems.
- B. Comply with Specifications and referenced standards as minimum requirements.
- C. Components required to be supplied in quantity within a Specification section shall be the same and shall be interchangeable.

1.04 WORKMANSHIP

- A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform work by persons qualified to produce workmanship for specified quality.
- C. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.05 MANUFACTURER'S INSTRUCTIONS

- A. When work is specified to comply with manufacturer's instructions, submit copies as specified in Section 01340, and distribute copies to persons involved, and maintain one set in field.
- B. Perform work in accordance with details of instructions and specified requirements. Should a conflict exist between Specifications and instructions, consult with the Engineer.

1.06 TRANSPORTATION AND HANDLING

- A. Provide equipment and personnel necessary to handle products, including those provided by Owner, by methods to prevent soiling or damage to products or packaging.
- B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.
- C. Handle products by methods to prevent bending or overstressing.
- D. Lift heavy components only at designated lifting points.

1.07 STORAGE AND PROTECTION

- A. Store Products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive Products in weather-tight enclosures and maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated Products, place on supports above ground. Cover Products subject to deterioration with impervious sheet covering; and provide ventilation to avoid condensation.
- C. Store loose granular materials on solid surfaces in a well-drained area; prevent mixing with foreign matter.
- D. Arrange storage to provide access for inspection. Periodically inspect to assure Products are undamaged and are maintained under required conditions.
- E. After installation, provide coverings to protect Products from damage from traffic and construction operations. Remove when no longer needed.
- F. During such periods of time that are designated by the United States Weather Bureau as being a hurricane warning or alert, construction materials or equipment shall be secured against displacement by wind and storm surge forces.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Comply with requirement stated in Conditions of the Contract and in specifications for administrative procedures in closing out the Work.
- B. Related Requirements Described Elsewhere:
 - 1. Cleaning: Section 01710
 - 2. Project Record Documents: Section 01720
 - 3. Warranties and Bonds: Section 01740.

1.02 SUBSTANTIAL COMPLETION

- A. The Work will not be substantially complete, and Contractor may not request substantial completion inspection unless the following submittals and work is completed:
 - 1. All Operation and Maintenance manuals have been submitted and approved.
 - 2. All start-up and demonstration testing completed, and Certificates of Completed Demonstration submitted.
 - 3. Project Record Documents have been submitted and reviewed to the requirements of Section 01720.
 - 4. All training of Owner's personnel completed.
 - 5. All areas to be used and occupied are safe, operable in automatic and complete.
 - 6. All deficiencies noted on inspection reports or nonconformances are corrected or the correction plan approved.
- B. When the conditions of paragraph 1.02 A. are met the Contractor shall submit to the Engineer:
 - 1. A written notice that he considers the Work, or portion thereof, is substantially complete, and requests an inspection.
 - 2. A punchlist of items to be corrected with a completion schedule.

- C. Within a reasonable time after receipt of such notice, the Engineer will make an inspection to determine the status of completion.
- D. Should the Engineer determine that the Work is not substantially complete:
 - 1. The Engineer will promptly notify the Contractor in writing, giving the reasons therefor.
 - 2. Contractor shall remedy the deficiencies in the Work and send another written notice of substantial completion to the Engineer.
- E. When the Engineer finds that the Work is substantially complete, he will:
 - 1. Schedule a walk-through of the facility to include the Owner, Engineer to determine the completeness of the punchlist and readiness of the facility for occupancy.
 - 2. Prepare and deliver to Owner a tentative Certificate of Substantial Completion with the tentative punchlist of items to be completed or corrected before final inspection.
 - 3. After consideration of any objections made by the Owner, and when the Engineer considers the Work substantially complete, he will execute and deliver to the Owner and the Contractor a definite Certificate of Substantial Completion with a revised tentative list of items to be completed or corrected. Any incomplete work allowed on a punchlist must be reinspected upon completion and any deficiencies found will be added to the punchlist.

1.03 FINAL INSPECTION

- A. Prior to Contractors request for a final inspection the following submittals and work must be complete:
 - 1. Project Record Documents must be approved.
 - 2. All spare parts must be suitably delivered.
 - 3. Contractor to submit evidence of compliance with requirements of governing authorities.
- B. After satisfying the requirements of paragraph 1.03 A. and when Contractor considers the Work complete, he shall submit written certification that:
 - 1. Contract Documents have been reviewed.
 - 2. Work has been inspected for compliance with Contract Documents.
 - 3. Equipment and systems have been tested in the presence of the Owner's representative and are operational.

4. All punchlist items have been corrected.
- C. The Engineer will, within reasonable time, make an inspection to verify the status of completion with reasonable promptness after receipt of such certification.
- D. Should the Engineer consider that the Work is incomplete or defective:
1. The 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 another written certification to the Engineer that the Work is complete.
 3. The Engineer will, within a reasonable amount of time, reinspect the Work and the Contractor shall be liable for reinspection fees as described in paragraph 1.04, herein.
- E. When the Engineer finds that the Work is acceptable under the Contract Documents, the Contractor may make closeout submittals.

1.04 REINSPECTION FEES

- A. Should the Engineer perform reinspections due to failure of the Work to comply with the claims of status of completion made by the Contractor:
1. Contractor will compensate the Owner for such additional services.
 2. Owner will deduct the amount of such compensation from the final payment to the Contractor.

1.05 CONTRACTOR'S CLOSEOUT SUBMITTALS

- A. Warranties and Bonds: To requirements of Section 01740.
- B. Evidence of Payment and Release of Liens: To requirements of General and Supplementary Conditions.
- C. Certificate of Insurance for Products and Completed Operations.

1.06 FINAL ADJUSTMENT OF ACCOUNTS

- A. Submit a final statement of accounting to the Engineer.
- B. Statement shall reflect all adjustments to the Contract Sum:
1. The original Contract Sum.
 2. Additions and deductions resulting from:

- a. Previous change orders or written amendment.
 - b. Allowances.
 - c. Unit prices.
 - d. Deductions for uncorrected work.
 - e. Deductions for liquidated damages.
 - f. Other adjustments.
- 3. Total Contract Sum, as adjusted.
 - 4. Previous payments.
 - 5. Sum remaining due.
- C. Engineer will prepare a final Change Order, reflecting approved adjustments to the Contract Sum which were not previously made by Change Orders.

1.07 FINAL APPLICATION FOR PAYMENT

- A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the Conditions of the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01710

CLEANING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Execute cleaning, during progress of the Work and at completion of the Work.

1.02 DISPOSAL REQUIREMENTS

- A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Use only those cleaning materials which will not create hazards to health or property, and which will not damage surfaces.
- B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.
- C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

3.01 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 or personal activities.
- B. Provide on-site containers for the collection of waste materials, debris and rubbish.
- C. Remove waste materials, debris and rubbish from the site as needed and dispose of at legal disposal areas away from the site.

3.02 DUST CONTROL

- A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until paint is finished.
- B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

- A. Employ skilled workmen for final cleaning.
- B. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces.
- C. Prior to final completion, or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas, to verify that the entire Work is clean.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Maintain, for the Engineer, one (1) record copy of:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications of the Contract.
5. Engineer's Field Orders or written instructions.
6. Approved Shop Drawings, Working Drawings and Samples.
7. Field Test records.
8. Construction photographs.

B. Related Requirements Described Elsewhere:

1. Shop Drawings, Working Drawings and Samples: Section 01340.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store documents and samples apart from documents used for construction.

1. Provide files and racks for storage of documents.
2. Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with CSI format with section numbers as provided herein.

C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.

D. Make documents and samples available at all times for inspection by the Engineer.

- E. As a prerequisite for monthly Progress payments, the Contractor is to exhibit the currently updated "Record Documents" for review by the Engineer.

1.03 MARKING DEVICES

- A. Provide felt tip making pens for recording information in the color code designated by the Engineer.

1.02 RECORDING

- A. Label each document "PROJECT RECORD" in neat large printed letters.
- B. Record information concurrently with construction progress.
 - 1. Do not conceal any work until required information is recorded.
- C. Drawings: Legibly mark to record actual construction:
 - 1. Depths of various elements of foundation in relation to finish first floor datum.
 - 2. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc.
 - 3. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
 - 4. Field changes of dimension and detail.
 - 5. Changes made by Field Order or by Change Order.
 - 6. Details not on original Contract Drawings.
 - 7. Equipment and piping relocations.
 - 8. Major architectural and structural changes including relocation of doors, windows, etc.
 - 9. Architectural schedule changes according to Contractor's records and shop drawings.
- D. Specifications and Addenda: Legibly mark each section to record:
 - 1. Manufacturer, trade name, catalog number of Supplier of each product and item of equipment actually installed.
 - 2. Changes made by Field Order or by Change Order.

- E. Shop Drawings (after final review and approval): Provide five (5) sets of record drawings for each process equipment, piping, electrical system and instrumentation system.

1.04 SUBMITTAL

- A. At Contract closeout, deliver Record Documents to the Engineer for the Owner.
- B. Accompany submittal with transmittal letter in duplicate, containing:
 - 1. Date.
 - 2. Project title and number.
 - 3. Contractor's name and address.
 - 4. Title and number of each Record Document.
 - 5. Signature of Contractor or his authorized representative.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01740

WARRANTIES AND BONDS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work:
 - 1. Compile specified warranties and bonds as specified in these Specifications.
- B. Related Work Described Elsewhere:
 - 1. Contract Closeout: Section 01700.

1.02 SUBMITTAL REQUIREMENTS

- A. Assemble warranties, bonds and service and maintenance contracts, executed by each of the respective manufacturers, suppliers, and subcontractors.
- B. Number of original signed copies required: Two (2) each.
- C. Table of Contents: Neatly typed, in orderly sequence. Provide complete information for each item.
 - 1. Product of work item.
 - 2. Firm, with name of principal, address and telephone number.
 - 3. Scope.
 - 4. Date of beginning of warranty, bond or service and maintenance contract.
 - 5. Duration of warranty, bond or service maintenance contract.
 - 6. Provide information for Owner's personnel:
 - a. Proper procedure in case of failure.
 - b. Instances which might affect the validity or warranty or bond.
 - 7. Contractor, name of responsible principal, address and telephone number.

1.03 FORM OF SUBMITTALS

- A. Prepare in duplicate packets.

- B. Format:
1. Size 8 1/2 inches by 11 inches, punched sheets for standard three (3) ring binder.
 - a. Fold larger sheets to fit into binders.
 2. Cover: Identify each packet with typed or printed title "WARRANTIES AND BONDS." List:
 - a. Title of Project.
 - b. Name of Contractor.
- C. Binders: Commercial quality, three (3) D-ring type binders with durable and cleanable white plastic covers and maximum D-ring width of two (2) inches. Binders shall be presentation type with clear vinyl covers on front, back, and spine. Binders shall include two sheet lifters and two horizontal inside pockets.

1.04 WARRANTY SUBMITTALS REQUIREMENTS

- A. For all major pieces of equipment, submit a warranty from the equipment manufacturer. The manufacturer's warranty period shall be concurrent with the Contractor's for one (1) year, unless otherwise specified, commencing at the time of final acceptance by the Owner.
- B. The Contractor shall be responsible for obtaining certificates for equipment warranty for all major equipment specified under Divisions 11: Equipment; 13: Special Construction; 15: Mechanical; and 16: Electrical and which has at least a 1 hp motor or which lists for more than \$1,000. The Engineer reserves the right to request warranties for equipment not classified as major. The Contractor shall still warrant equipment not considered to be "major" in the Contractor's one-year warranty period even though certificates of warranty may not be required.
- C. In the event that the equipment manufacturer or supplier is unwilling to provide a one (1) year warranty commencing at the start of the Correction Period, the Contractor shall obtain from the manufacturer a two (2) year warranty commencing at the time of equipment delivery to the job site. This two (2) year warranty from the manufacturer shall not relieve the Contractor of the one (1) year warranty, starting at the time of Owner's acceptance of the equipment.
- D. The Owner shall incur no labor or equipment cost during the guarantee period.
- E. Guarantee shall cover all necessary labor, equipment, materials, and replacement parts resulting from faulty or inadequate equipment design, improper assembly or erection,

defective workmanship and materials, leakage, breakage or other failure of all equipment and components furnished by the manufacturer or the Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 11214

VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Manufacture, assemble, shop test, and deliver vertical turbine pumps, and motors as hereinafter specified, and as shown on the Drawings. Which are to replace the existing high service pumps at the Goodland Pump Station. In general, the following equipment shall be furnished:
 - a. Four (4) high service pumps with 40 horsepower motors rated for 600 gpm at 185 feet TDH.
2. The equipment is to be installed by the contractor, who will be responsible for installing the equipment in accordance with the manufacturer's recommendations. Installation will include mounting the unit, piping the unit, and providing power to the unit and panels and all interconnected wiring and piping required between various components.
4. The pump shall each be factory tested prior to shipment.
5. The equipment shall be shipped in a minimum number of components comprised of the pump assembly and the motor.
6. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment application. It is, however, intended to cover the furnishing, the shop testing, the delivery of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.

B. General Design

1. All pumps will be of the above base discharge, below base suction, vertical turbine can installation type. All high service pumps are to be driven by variable frequency drives. The pumping units will be installed as shown on the Drawings.
2. All working parts of identical pumps and motors, such as bearings, wearing rings, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All

parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance Manuals furnished.

3. The bearing spacing shall be short enough such that the 1st critical speed is 20% above the maximum operating speed.
4. All pumping equipment, coatings, and materials that come in contact with the pumped water, including the complete pumping unit, shall be National Sanitation Foundation (NSF) Standard 61 approved for use with potable water, and the pump manufacturer shall provide documentation to demonstrate compliance.

1.02 QUALITY ASSURANCE

A. Qualifications

1. To assure unity of responsibility, the motors shall be coordinated and furnished by the pump manufacturer.
2. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having a minimum 10-years experience in the production of such pumps. The pumps furnished shall be designed and constructed in accordance with the best practice and methods and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.
3. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein.

B. Manufacturers

1. The naming or reference to a specific manufacturer does not indicate that the manufacturer's standard equipment is acceptable in lieu of the specified component features. This reference is only an indication that the named manufacturers may have the capability of supplying the equipment as specified.
2. The pumps shall be manufactured by:
 - a. Goulds.
 - b. Flowserve.
3. The motors, which are required to be coordinated and supplied by the pump manufacturer, shall be manufactured by:
 - a. U.S. Electric Motor.
 - b. Reliance Electric Co.

- c. General Electric Co.

1.03 SUBMITTALS

A. Materials and Shop Drawings

Upon execution of the contract with the County, but prior to production of the equipment, submit copies of shop drawings required to establish compliance with this Specification for review and approval by the Engineer (Tetra Tech). Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions, and anchor bolt locations.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of the actual units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHr, and horsepower. Curves shall be plotted from no flow at shut off head to maximum pump capacity.
4. Data including principle dimensions, materials of construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.
5. A complete total bill of materials of all equipment including the weights of equipment furnished.
6. A list of the manufacturer's recommended spare parts, with the manufacturer's current price for each item. Include gaskets, packing, etc., on the list. List bearings by the bearing manufacturer's numbers only.
7. Complete motor data.
8. Documentation that the specific vertical turbine pumping unit model, complete and with materials of construction matching the units to be supplied on this project, and also all applied coatings in contact with the pumped water, has received NSF Standard 61 approval for use with potable water.
9. Submittal data shall be complete and no partial submittals will be accepted.

B. Submit detailed pump structural frequency analysis for each variable speed pump system:

1. The pump supplier shall provide an analysis of each vertical variable speed pump system to ensure that no damaging critical or resonant frequencies or multiplies of resonant frequencies occur from 15% above to 20% below the proposed speed range necessary for the pump to meet the specified operating conditions.
2. A computer program shall be used to generate the pump structural natural frequencies based on a comprehensive procedure. This procedure shall be applicable for vertical pumps.
3. The frequency analysis shall include but not be limited to:
 - a. The combined rotational stiffness of the discharge head flange, discharge head flange bolting, base plate/sole plate, and anchor bolting of a vertical pump.
 - b. The rotational dynamics of the motor.
4. The analysis shall be performed and certified by a registered professional engineer and calculations shall be provided to the Engineer with submittal data. The registered professional engineer shall certify the pump when operating from 70% full speed to 100% full speed does not come within 20% of the first or second critical harmonic speed.

C. Additional Information

1. In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Instructions

1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment.
2. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 TOOLS AND SPARE PARTS

- A. Furnish to the Owner a complete set of all special tools, including lubricating devices, required for normal operation, adjustment and maintenance of the equipment supplied. All such tools shall be furnished with a heavy duty, thermoplastic tool chest complete with a padlock and duplicate keys.
- B. The manufacturer shall furnish a complete set of recommended spare parts necessary for the pumping system. Furnish for each size and type of pump the recommended spare parts, which shall include, as a minimum, the following:
 - 1. Two (2) sets of gaskets and O-rings.
 - 2. Two (2) sets of mechanical seals.
 - 3. One (1) year's supply of lubricant required.
 - 4. Two (2) sets of lineshaft bearings.
- C. All spare parts shall be furnished in containers properly labeled and identified with indelible markings as to their contents without opening the packaging. Containers shall be suitably protected for long-term storage.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- B. All equipment and parts must be properly protected against any damage during a prolonged storage period at the site.
- C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- D. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.
- E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.
- G. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.07 WARRANTY AND GUARANTEES

- A. Each unit shall be warranted to be free from defects in materials and workmanship

for a period of twelve (12) months after Owner acceptance as defined in Part III of this specification, not to exceed a period of twenty-four (24) months from shipment. The warranty shall cover all repairs for all systems furnished by the manufacturer. Manufacturer shall repair or replace, at its option, any such equipment found to be defective, provided written notice of the defect is received within twelve (12) months after acceptance, and not exceed a period of twenty-four (24) months from shipment.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The pumping units required under this section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.
- B. Provide all necessary anchor bolts, nuts, and washers for anchoring head base into concrete pedestal and bolts, nuts, washers, and o-ring for connecting discharge head to suction vessel. Anchors, bolts, nuts and washers shall be Type 316 stainless steel.
- C. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump and motor.
- D. Each pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to backflow through the pump with the maximum TDH specified available at the pump discharge flange.
- E. The specific vertical turbine pumping unit model, complete and with materials of construction matching the units to be supplied on this project, and also all applied coatings in contact with the pumped water, shall have received NSF Standard 61 approval for use with potable water.

2.02 MATERIAL AND EQUIPMENT

- A. General
 - 1. The high service pumps shall be variable speed, water lubricated, open line shaft, vertical turbine type suitable to pump potable water from the storage tanks into a pressurized distribution network.
 - 2. The pumps shall be of standard dimensions such that parts will be interchangeable between like units and all units shall be supplied by the same manufacturer.
- B. Performance Requirements

1. When operating at the maximum output speed of the motor, the pump shall have a characteristic performance curve, which meets all the conditions listed in Table 11214-B. The pump and drive motor shall be capable of operating satisfactorily under the full range of conditions as defined by Table 11214-B. The Primary Capacity, head and efficiency defined in Table 11214-B shall be the "design point." Pump efficiency as defined herein takes into consideration all losses from the pump suction bell to the pump discharge flange.
2. There shall be no significant change in vibration and noise level over the entire listed range of flow for the pumping system.
3. Maximum motor speeds shall not exceed those listed in Table 11214-B to satisfy the specified hydraulic duty requirements. The pump "design speed" shall be the maximum output speed of the motor when operating at the pump Primary Capacity and head.
4. Primary Capacity and minimum head at Primary Capacity, referred to as the Primary Condition, shall be taken as the rated operating condition while operating at maximum speed. Primary Condition has been selected to obtain the rated pumping capacity for the installation. Performance at the rated condition shall be guaranteed. The pumps need not be selected for maximum efficiency at the Primary Condition, but the Primary Capacity shall be in the range of 0% to 10% higher than the flow at the best efficiency point (BEP) at full speed, so that the BEP tracks through the system curve at reduced speeds. Pumps furnished under this section should be selected to achieve Primary Condition performance, but also operate continuously without objectionable vibration or cavitation at the Secondary Capacity. The NPSHr must be no higher than the maximum listed at the Primary Capacity.
6. Secondary Capacity represents operating conditions when the pump is operating at maximum speed against minimum anticipated system head, assuming a hypothetical head-capacity curve. The Secondary Capacity must be shown on the manufacturer's published performance curve data for the specific model proposed for this application and the TDH at the Secondary Condition shall be no higher than the maximum TDH listed. Pumps with less TDH at the Secondary Capacity than the specified maximum TDH are acceptable. Proposed pump selections meeting this discharge head requirement by operating the equipment at less than full speed will be rejected. The pumps shall be capable of operating at the Secondary Capacity without vibration, cavitation, or excessive wear.
7. Certified Factory Tests
 - a. Each pump shall be given a complete non-witnessed factory performance test to include head vs. capacity, brake HP, NPSHr, and efficiency to demonstrate that the pumps supplied conform to the requirements of this Specification. Factory testing shall be conducted

in accordance with Hydraulic Institute Standards (ANSI/HI 14.6), using the actual job driver. Copies of the approved pump test curves shall be provided to the Engineer (Tetra Tech) for review and approval prior to shipment. The curves shall be plotted from zero flow at shut off head to the Secondary Capacity or greater. No shipment of the pumps is to be made until after the Engineer's approval of the testing is obtained. The curves shall indicate the pump number, manufacturer, model number, and serial number. The tested pumps shall meet Hydraulic Institute acceptance level 1B with the exception that that the brake HP may not exceed motor rating, to be approved for shipment.

- b. The pump manufacturer shall have power-metering instruments in-place for continual monitoring of 480 volt, 3-phase, 60 Hertz power draw on each pumping unit. The manufacturer must demonstrate during the entire factory test that the brake HP does not exceed the motor rating and that hydraulic efficiency requirements are in compliance with this specification. Overloading of the motor and/or failure of the pumping equipment to meet efficiency requirements will be grounds for failing the factory test. Monitoring of vibration shall be provided by the manufacturer during performance testing in accordance with the Hydraulic Institute Standards. Excessive vibration will be grounds for failing the factory test.
- c. Failed Factory Test: The failure of any pumping equipment to produce the specified flow rate over the entire test period will constitute a failed factory test. If a failed factory test occurs, manufacturer shall, at no expense to the Owner, make such modifications and perform additional tests as may be necessary to comply with the specifications.

C. Discharge Heads

- 1. Provide a fabricated steel discharge head. The discharge head shall have bolted register or rabbet-fit connections for the motor. Discharge head shall have connections for the pump column and discharge piping and shall support the weight of the various items as well as hydrostatic and hydrodynamic loads. Fabricated discharge heads shall be either 3-piece mitered elbow, 2-piece fabricated elbow, or long radius elbow.
- 2. The discharge head shall be furnished with an integral-mounting ring of adequate design with registered fit to match the mounting dimensions of the drive and to support the drive weight and hydraulic thrust of the pump. Discharge heads shall be fitted with a ANSI B16.5 150 lb flat face flange discharge with holes straddling vertical centerline and connection to match the deck plate or barrel flange.

3. OSHA guards shall be supplied for all rotating assemblies and shall be fabricated of Type 316 stainless steel.
4. The fabricated discharge head shall incorporate a four (4) piece spacer coupling. The coupling shall consist of one (1) motor half coupling, one (1) pump half coupling, one (1) internal threaded adjusting plate, and a spacer. The assembly shall be joined together by a minimum of four (4) bolts complete with lock washers. The motor half coupling shall be fitted with one (1) stainless steel split ring key and one (1) vertical shaft key. The pump half coupling shall be fitted with a vertical shaft key. The impeller shall be axially adjustable by means of the adjusting plate threaded onto the pump shaft. The spacer shall be of ample size to permit removal of the mechanical seal assembly without removing the motor. The assembly shall be manufactured of Type 416 stainless steel.
5. The mechanical shaft seal shall be a balanced internal type seal that includes a Type 316 stainless steel seal flange with ports for recirculation and venting. The rotating assembly shall be secured to a shaft sleeve that will seal against the shaft with a viton O-ring seal. The shaft sleeve shall attach to the shaft by means of a Type 316 stainless steel locking collar. The seal rotating housing, disc plate and spring shall be manufactured of Type 316 stainless steel. The rotating washer shall be of silicon construction. The stationary seal shall be a viton O-ring fitted into the seal flange and manufactured from tungsten. The seal shall be John Crane Type T-5610, Flowserve ISC2 or an approved equal.
6. The discharge head shall be provided with the following four (4) NPT threaded half coupling connections, which shall be separate, and provided with a removable NPT threaded plug.
 - a. Discharge Pressure Connection - Size 3/4" NPT
 - b. Discharge Vent Connection - Size 3/4" NPT
 - c. Seal Plate Drain Connection - Size 3/4" NPT
 - d. Barrel Vent Connection - Size 1" NPT

D. Column and Lineshafting

1. The column pipe shall have flanged connections with fabricated or insert type integral bearing retainers.
2. The outer column shall be of steel. The weight of the column shall be no less than that stated in ANSI Specification B58.1. Friction loss through the columns shall not exceed 5 feet per 100 feet.
 - a. Shafting shall be polished over its full length.
 - b. Total lateral deflection of the shaft above the packing box shall not exceed 0.007-inch total indicator reading. Shaft couplings for shaft

diameters two (2) inches or larger shall be of the key and thrust-ring types or other non-threaded design.

- c. Lineshafting shall not exceed 10 feet in length and shall have butting faces machined square to the axis of the shaft with angular misalignment of thread and shaft axis not exceeding 0.002 inches in 6 inches.
- d. Threaded couplings may be used for shaft diameters smaller than two (2) inches.
- e. Pumps shall have open self-lubricated lineshafts.

E. Bowl Assembly

- 1. Each bowl assembly shall consist of the discharge bowl, impeller and impeller shafting, and bearings. Bearings shall be located above and below the impeller.
- 2. Pump bowls shall be sufficiently rigid to prevent adverse changes in bearing alignment and to maintain the running clearance of seal rings. Bowl to bowl fits shall be rabbet fit.
- 3. Bowls shall be flanged with male and female rabbet or threaded for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be smooth and free from nodules, bumps and dips.
- 4. The maximum allowable bowl outside diameter is 8”.

F. Suction Bell: The suction bell shall have, as an integral part, vanes supporting a central hub in which the bottom bearing is carried below the impeller. The suction bell outside diameter dimension shall be no larger than 8”. Maximum entrance velocity shall not exceed six (6) fps. The contour between the outer edge and the impeller suction eye shall be smooth, continuous and bell shaped. The suction bell is to be without a basket strainer (or vortex suppressor similar to a basket strainer) as is illustrated in Hydraulic Institute Figure 9.8.2.6.5. The pump length shall be such that the clearance from the suction bell to the floor of the can is equal to half the bell diameter or the manufacturer’s recommended clearance.

G. Impellers:

- 1. Pump impellers shall be of the closed type. Impellers shall be of a material suitable for service with a highly chlorinated water. Impellers shall be cast in one piece and machined to fit the contour of the bowl. Impellers shall be equipped with replaceable wear rings or with wearing ring hubs for mounting wear rings during future repair or with a bronze bowl liner.

2. Attach impellers to the shaft with 316 stainless steel tapered collets or with a Type 316 stainless steel split ring and key.
3. Static and dynamic balancing of the impellers is required.

I. Motors

- a. Shall comply with the following sections of this specification as well as specification 16220.

1. General

- a. The motors for the pumps shall be of the vertical solid shaft squirrel cage induction type.
- b. Motors must be designed to accept all up thrust loads imposed by pump during starting and running.
- c. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.
- d. Motors shall conform to all requirements stipulated in PART 1 GENERAL of this Section of the Specifications unless modified in this paragraph.
- e. Provide shaft grounding rings for each vertical turbine pump.

2. Performance Requirements

- a. Motors shall be premium efficiency rated 460 volts, 3 phase, 60 Hertz. Motors shall be suitable for VFD application. All motors shall be nameplated as inverter duty.
- b. Each motor shall have a 1.15 service factor.
- c. Motors shall have horsepower conforming to the requirements of Table 11214-B.
- d. Motors shall be free of objectionable noise and vibration. Vibration level measured on the bearing housing shall be in accordance with values shown in NEMA and Hydraulic Institute Standards.
- e. Maximum temperature rise of the motor windings shall not exceed 80°C as measured by resistance, when motor is operated continuously at rated horsepower, rated voltage and frequency in ambient air temperature of 40°C.

3. Construction

- a. The pump motors shall be of the open drip proof (ODP) design.
- b. Motor frames and end shields shall be heavy fabricated steel or cast iron of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed. Openings for ventilation shall be uniformly spaced around the motor frame.
- c. Space heaters shall be provided to operate on 120-volt, single phase power. Leads shall be brought out to a terminal block enclosed in a NEMA 4 accessory box. Motors shall be provided with a metallic foil or plastic warning label with red background and white letters which has the following legend: "WARNING - ELECTRICAL SHOCK HAZARD, Motor Equipped with Strip Heaters. Strip Heater Circuit remains Energized when Main Disconnect for Pump is OFF".
- d. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.
- e. Stator cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations.
- f. Stators shall be random wound and insulated with glass and mica applied directly to the coils. Motors shall have a Class B rise non-hygroscopic epoxy sealed or encapsulated insulation system. All connections shall be silver soldered with no crimp connections used. A coil bracing system for stator end turns shall be utilized to minimize coil movement during starting and running conditions.
- g. Rotors shall be made from high grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel cage may be of cast-aluminum or copper alloy bar-type construction with brazed end rings.
- h. Thrust bearings shall be oil or grease lubricated antifriction type with an AFBMA average bearing life of 20 years.
- i. The motor thrust bearing shall have ample capacity to carry the weight of all the rotating parts plus the hydraulic thrust of the pump impellers and have an ample safety factor. This factor should be based on an average life expectancy of five years operation at 24 hours per day.
- j. All motors shall have an interior coating of chemical resistant corrosion and fungus protective coating on all interior surfaces. Exterior prime coating shall be compatible with the field applied finish coating.

- k. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all motors capable of supporting the weight of the motor. Enclosures shall have stainless steel insert screens.
- l. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.
- m. The main terminal box shall be NEMA 4X and provide ample room for connections.
- n. Motors shall be provided with a non-reverse ratchet coupling assembly.
- o. Provide a coupling guard on the pump base to prevent personal injury from the rotating pump and motor coupling. The guard shall be manufactured of stainless-steel wire fabric or expanded metal and shall comply with all applicable OSHA requirements. The guard shall be bolted or screwed to the pump base with stainless steel bolts and nuts or screws and shall be easily removable for access to the pump and motor coupling.
- p. Equip motor with thermal protection in accordance with NEMA MG 1. Control leads shall be colorcoded, brought out to the motor conduit box or a separate terminal box for connection. Provide three series-connected, normally closed switches, one in each winding.

J. Tests

1. All motors shall be completely assembled at the factory and shall be given routine tests conducted in accordance with NEMA Standards MG1-20.46 and MG1-20.47 which includes the following non-witnessed tests:
 - a. No load current.
 - b. Winding resistance.
 - c. High potential dielectric tests.
 - d. Bearing inspection.
2. The pump manufacturer shall be responsible for coordinating with the motor manufacturer and requiring any additional testing that may be needed to ensure the combined pump/motor assembly will meet the efficiency requirements of this specification.
3. Copies of the test results for each motor shall be certified by a responsible test engineer. The test results shall be furnished to the Engineer for review before shipment of the motors.

2.03 ACCESSORIES

- A. Fasteners: All pumps and column fasteners shall be of Type 316 stainless steel.

2.04 SHOP PAINTING

- A. The interior and exterior of the pump columns, the interior and exterior of the pump bowls, the interior of the discharge heads, and any other ferrous metal surface shall be coated with a high build modified epoxy. The coating shall have a dry film thickness of at least 10 mils.
- B. The exterior and interior of the pump discharge head shall be coated with high build modified epoxy.
- C. Coatings contacting the water pumped shall be NSF-61 approved for use with potable water.
- D. Shop Painting
 - 1. Before exposure to weather and prior to shop painting all surfaces shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter.
 - 2. All exposed portions of the pumps and motors shall be shop coated.
 - 3. All nameplates shall be properly protected during painting.
 - 4. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

PART 3 - EXECUTION

3.01 INSPECTION, TESTING, START-UP, AND INSTRUCTION

- A. General
 - 1. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least two (2) days shall be allocated solely to the instruction of personnel in operation and maintenance of the equipment.

This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to start-up and acceptance by the Owner. The final copies of operation and maintenance manuals must have been delivered prior to scheduling the instruction period. The costs for all of those services are to be included in the cost of the pumps but services are to be held in abeyance until the installation has been completed by a contractor.

TABLE 11214-A
MATERIALS OF CONSTRUCTION

Component	Material
Pump shafts, shaft couplings, and sleeves	Stainless Steel, ASTM A276, Type 410, Type 416, or 316 or 17-4PH Stainless Steel
Bearing retainers (fabricated integral)	Carbon steel, ASTM A36 Grade B, ASTM A283, Grade B or Aluminum Bronze, ASTM B505 C95400, or Stainless Steel ASTM A276, Type 304
Bearing retainers (insert type)	Cast Iron ASTM B584, Bronze Alloy C 93700 or C-83600, or Stainless Steel ASTM A276, Type 304
Impellers	Aluminum Bronze, ASTM B148 C95200, Bronze, Alloy C 90300 or C-83600 or stainless steel ASTM A276, Type 316
Pump bowls and suction intake	Cast Iron, A 48, Class 30
Bowl bearings	Bronze, Alloy C89835 or Bronze, B584, Alloy C84400; SAE 660 Bronze, Alloy 932.00
Lineshaft bearings	Neoprene, EPDM, or Nitrile
All parts made of fabricated steel including discharge heads or motor stands, unless specified otherwise	Carbon steel, ASTM A283, Grade B or C, or ASTM A53, Grade B
Column pipe	Carbon steel, ASTM A36, Grade B, ASTM A283, Grade B or C, or ASTM A53, Grade B
Flanges	ASTM A105, A181, or A182
Bolts and nuts for discharge head and column pipe flanges, coupling guard	Bolts shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M. Nuts shall be Type 316 stainless steel conforming to ASTM A194, Grade 8M
Stuffing box gland parts	Bronze, ASTM B584, Alloy 836, or ASTM B62 or 416 Stainless Steel, or ASTM A226, Type 316
Gland nuts and bolts	Stainless steel, ASTM A 276, Type 316 bolts with Bronze nuts
Notes:	
1. The pump is to be NSF-61 approved for use with potable water.	

TABLE 11214-B
PUMP DESIGN REQUIREMENTS

Criteria	High Service Pumps
Number of Pumps	4
Max. Motor Full Load Speed (rpm)	1,800
Max. Motor Power (HP)	40
Speed Control	VFD
Pump Design Speed (rpm)	motor full load speed
Max. Allowed Pump Horsepower at Design Speed (HP)	40
Pumping Medium	potable water
Max. Medium Temperature	80 deg F
Pump Can Outside Diameter (in)	10
Pump Can Inlet Flange Size (in) ¹	8
Min. Pump Discharge Head Connection Size (in)	8
Primary Capacity (gpm)	600
Min. TDH at Primary Capacity (feet)	185
Min. Pump Efficiency at Primary Capacity (%)	75
Secondary Capacity, gpm	400
Max. TDH at Secondary Capacity (ft) ²	200
Max. NPSHr at Primary Capacity (ft)	12
Allowable Pump Make and Model	Goulds 8FDHC Flowserve 8****
Notes: 1. Pump with TDH less than the listed maximum TDH at the secondary capacity are acceptable. 2. The tested pumps shall meet Hydraulic Institute acceptance level 1B with the exception that that the brake HP may not exceed motor rating.	

END OF SECTION

SECTION 11220
SUBMERSIBLE MIXER

PART 1 – GENERAL

1.01 SCOPE

- A. This section covers submersible tank mixing systems up to 0.5 HP in size intended for continuous use while submersed in potable water storage tanks. Each mixer shall have the ability to function continuously on a year-round basis, regardless of drain and fill cycles. Each mixer shall consist of a water-filled submersible motor, a nozzle mounted on a submersible stainless-steel casing, and a non-submersible control center that houses all control electronics.

1.02 THE REQUIREMENT

- A. CONTRACTOR shall furnish a PWM150 PAX Mixer with the optional SCADA Interface and install submersible mixing system together with controls and accessories necessary for a complete and operable system.
- B. CONTRACTOR shall furnish electrical conduit with 115VAC Single Phase voltage based on System configuration. Depending on the configuration, the following needs to be installed:
 - 1. A 20 Amp GFCI 300mA trip level circuit breaker up to the point of installation of the 115VAC single phase mixing system when no PAX control center is installed.
- C. CONTRACTOR shall also provide conduit from control center to tank penetration for submersible motor cable and penetration through tank for same cable.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Comply with the applicable reference specifications as specified in the General Requirements
- B. Occupational Safety and Health Administration, OSHA
- C. NSF/ ANSI Standard 61
- D. Underwriters Laboratories Inc., UL 508

1.04 CONTRACTOR SUBMITTALS

- A. NSF Certification
 - 1. Copies of the NSF-61 certified listing for all submersible mixer material being placed inside the tank and headspace, including the motor and power cable.
- B. Installation, Operations, and Maintenance Manuals shall be obtained from the equipment manufacturer and submitted. The following sections shall be included:
 - 1. General equipment specifications and data sheets.

2. Installation, start-up, operation, and maintenance instructions
3. Factory-recommended maintenance schedule
4. Wiring diagrams specifying what electrical wiring needs to be done onsite during and prior to the installation, and by which responsible party.
5. List of equipment or tooling necessary for diagnostics, troubleshooting, repair, or general maintenance.

1.05 QUALITY ASSURANCE

- A. Each mixing system shall be tested prior to deployment according to the manufacturer's standard factory testing practices at the factory testing facilities.
- B. Complete mixing system is NSF/ANSI Standard 61 certified by NSF.

1.06 WARRANTY

- A. For the period beginning with installation or 3 months after shipment to Buyer, whichever is earlier and ending 60 months thereafter, the mixer, including its associated controller, is warranted to be free from defects in material and workmanship and to conform to Seller's specification applicable to the product.

PART 2 – PRODUCTS

3.01 PERFORMANCE

- A. Mixing system shall completely mix reservoir according to the following minimum performance requirements. These requirements shall be measured and validated after installation by operators with the help of mixer manufacturer with readily available tools such as temperature probes and total chlorine grab samplers.

1. Temperature Uniformity

For tanks up to 750,000 gallons in volume: All temperatures shall converge to within 0.50°C within 24 hours after mixer is installed and activated.

2. Disinfectant Residual Uniformity

For tanks up to 750,000 gallons in volume: Disinfectant residual within top five feet of tank and bottom five feet of tank will converge to within 0.20 ppm within 24 hours after mixer is installed and activated. During continuous operation of the mixer, disinfectant residual will converge to within 0.20 ppm at least once every 24 hours.

3.02 GENERAL

- A. Mixing system consists of a nozzle mounted in a submersible stainless-steel casing. System is lowered to the tank floor and creates a vertical flow pattern inside the tank. Devices with an externally mounted pump shall not be acceptable. Mixer operation shall be independent of tank drain and fill cycles to ensure constant mixing. Mixer shall weigh less than 45 pounds

(~20 kg) and be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.

- B. Mixing system inlet shall be elevated at a minimum of 6" above tank floor to avoid disturbing accumulated tank sediment or entraining particles and causing accelerated wear of moving parts.
- C. Mixers using submersible pump with slit or "water sheet" or horizontal motor mounting designs are not acceptable.
- D. Mixers shall include a buoyancy mechanism to keep nozzle pointing upright no matter the angle of the tank floor.
- E. Mixers shall include integrated power cable as a lowering mechanism for simplicity.
- F. Mixer provider must have more than 1000 installation of similar equipment in potable water tanks or reservoirs.
- G. Mixers shall have no oil-filled parts.
- H. All wet-side mixer components shall be certified by NSF to the NSF/ANSI Standard 61
- I. Dry-side mixer components shall include sine filter to prolong motor life and reduce noise level.
- J. Power source for mixer shall be 115VAC single phase grid power to allow unit to continue 24/7 operation.
- K. No regular, periodic maintenance required on the wet-side components in typical potable water application.
- L. No passive mixing system allowed.

3.03 CONSTRUCTION

- A. Components – wet-side: shall be certified by NSF to the NSF/ANSI Standard 61.

Equipment entering tank shall not adhere to, scratch or otherwise cause damage to internal tank coating or put undue stress on the materials of the tank construction. Equipment shall fit through a standard hatch of size 12" x12" or larger. UTILITY may prefer to puncture sidewall or ceiling of tank (in place of penetrating the hatchway) to allow motor cable entry into the tank and protection against freezing/ice damage.

Each submersible mixer shall consist of the following components, regardless of the power source selected:

1. Nozzle

AISI Type 316 Stainless Steel

2. Nozzle housing

AISI Type 316 Stainless Steel

Brush finish to minimize surface corrosion.

Buoyancy mechanism to keep nozzle pointing upright no matter the angle of the tank floor.

Chlorine/chloramine resistant rubber foot pad to avoid scratching tank floor.

Integrated power cable and lowering mechanism for simplicity

3. Motor

Stainless Steel 304 body

Chlorine/Chloramine resistant rubber seals

Fully submersible

Please select one of the two dry-side options below for control mechanism

A. Single Phase 115VAC configurations: Component – On/Off Safety Disconnect Switch with indicator light and SCADA Interface.

1. Enclosure

Type 4X

Lockable

Weather Resistant

Indicator light showing Mixer run status

Manual On/Off Switch

SCADA Interface: Digital output indicating motor running (Output contacts are SPDT, UL/CUR File E44211 Approved Contact Ratings)

2. Motor Controller/VFD

Rated to 1.0 HP

Operating temperature range -4 °F to 129 °F (-20 °C to 54 °C)

HOA Switch

Manual speed control

Thermal shut-off protection built-in

Current overload protection built-in

SCADA outputs included:

Digital Output signal indicating motor running

Digital Output signal indicating fault

Digital Input/output signal allowing remote motor on/off

RS-485 or Dry Contact connections

4-20mA Signal

3. GFCI-protection

115VAC, single-phase, with a 300mA trip level GFCI included inside control center.

4. Branch Circuit Protection

Panel equipped with a 115VAC 20-Amp main breaker.

5. Sine Filter

3.04 CONTROLS

A. Each unit shall be equipped with all necessary controls, inter-wired, to provide the following minimum functions:

1. On/Off switch to control power to mixer.
2. Automatically activated motor shut-off if water level drops below motor height in tank.
3. Sine filter

Any other controls shown on electrical and instrumentation drawings.

3.05 ACCEPTABLE MANUFACTURERS:

- A. PAX Water Technologies (Milpitas, California)
- B. COUNTY approved equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The CONTRACTOR shall furnish services of a factory-trained installation contractor or crew having experience with installation procedures and operation and maintenance requirements for the type of equipment installed under these specifications. Mixer must be able to be installed through a 12"x12" hatch. Mixer must be able to be installed without draining tank or taking tank out of service. Wet-side of Mixer shall weigh less than 45 pounds (~20 kg) and dry-side shall weigh less than 55 pounds (~25 kg). Both wet-side and dry-side shall be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.

- B. Tank penetration is recommended to be above tank water line, typically through the hatch sidewall.
 - 1. Fitting will prevent moisture intrusion into tank and ideally be horizontally oriented.
 - 2. Fitting shall be 1" diameter fitting to allow cable to pass through.
 - 3. Strain relief for power cable shall be part of the contractor-supplied fitting for tanks more than 30' in depth.
 - 4. For tanks more than 70' in depth, or at customer's discretion, a water-tight penetration may be installed under the waterline.
- C. Installation of the in-tank ("wet-side") components may be performed in any of the following ways:
 - 1. Installation below a hatch opening in a full tank utilizing the Mixer power cord.
 - 2. Installation by personnel with confined space training while the tank is drained and empty.
 - 3. Installation by tank manufacturer personnel during tank manufacture.
- D. Installation of the outside-of-tank ("dry-side") components may be performed by:
 - 1. Third party representatives or CONTRACTORS according to the manual provided.
 - 2. UTILITY personnel according to the manual provided.
- E. The mixer and optional SCADA interface or control center shall be installed in accordance with approved procedures submitted and Manufacturer's instruction supplied, unless otherwise approved in writing from the Manufacturer.

3.02 TRAINING

- A. PAX Water Technologies staff (or their representatives) will instruct designated UTILITY personnel in the safe and proper operation of the PAX Water Mixer. This training will reference the operations manual provided with equipment and show how to check for proper functioning of the equipment.

END OF SECTION

SECTION 11224

IN-LINE STATIC MIXERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. The Contractor shall furnish all labor, materials, equipment, and incidentals required to install the in-line static mixers as shown on the Drawings and specified herein.
2. The mixers are intended to rapidly mix chemical solutions into the process water to provide a homogeneous stream at the mixer outlet.

B. Related Work Described Elsewhere

1. Section 11241: Chemical Feed Systems.
2. Division 15 as applicable.

1.02 QUALITY ASSURANCE

- A. The static mixing equipment manufacturer(s) shall have experience in the design and manufacture of equipment of similar size and capacity and shall present proof of successful operations involving each piece of equipment furnished. All equipment shall be as manufactured by Statiflo, or an Engineer approved equal.
- B. Iron and steel products must be produced in the United States and certifications of such production must be provided to the Owner prior to installation.

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. Submit shop drawings and product data for equipment furnished under this section in accordance with Division 01: Shop Drawings, Working Drawings and Samples.
2. Submit mixing calculations for each static mixer demonstrating the mixing achieved at the minimum and maximum conditions as listed in Table 11224-1.

B. Additional Information

1. Equipment Installation Certificate: The manufacturer shall provide a written report, through the Contractor and endorsed in writing by the Contractor, certifying that the equipment has been professionally installed and checked and

is ready for placement into routine permanent service.

1.04 OPERATIONS AND MAINTENANCE DATA

- A. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Division 01.
- B. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided for one (1) day to instruct representatives of the Owner and the Engineer on proper operation and maintenance. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. The equipment provided under this section shall be shipped, handled, and stored in accordance with the manufacturer's written instructions, and in accordance with Division 01.

1.06 WARRANTY AND GUARANTEES

- A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Division 01. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for two (2) years, commencing at the time of final acceptance by the Owner.

PART 2 PRODUCTS

2.01 GENERAL

- B. The Post Treatment static mixer will be used to blend 25 percent sodium hydroxide and 12.5 percent sodium hypochlorite into the purified water stream. The mixer shall include two (2) injection nozzles for each chemical and shall be capable of blending the chemicals and filtrate water into a homogenous solution over the process water flow range listed in Table 11224-A. The specific Coefficient of Variation (CoV) should be achieved within three (3) diameters downstream of the mixing elements. The pressure drop across the mixer shall not exceed the values listed at the maximum flow rate.

2.02 MATERIALS AND EQUIPMENT

- A. All products that come into contact with raw, partially-treated or treated potable water shall include documentation showing product certification to NSF International Standard 61 by an ANSI accredited third-party certification body.

B. The Sodium Hydroxide and Sodium Hypochlorite Post Treatment Static Mixer,

1. The mixer shall be furnished complete with 316L stainless steel, or 150 psi rated filament wound Fiberglass Reinforced Plastic (FRP) components, including the flanged end body, internal baffle elements, and all other necessary appurtenances for each static mixer.
2. The mixer housing and mixing elements shall be constructed of 316L stainless steel or FRP. The mixer housing shall have a 14-inch nominal diameter and be constructed with 316L Schedule 40 stainless steel, or 150 psi rated FRP with Class 150-pound raised face slip-on (RFSO) flanges. Teflon full-face gaskets, 1/8-inch thick, shall be provided for RFSO flanges. The mixer shall be able to withstand an internal pressure of 150 psi. The mixer housing, mixing elements and injectors shall be able to withstand a temperature of 250°F and a minimum pH of 2.0.
3. The number of mixing elements shall be as recommended by the mixer manufacturer for the use intended. A minimum of three (3) elements shall be provided. Overall length shall not exceed the criteria listed in Table 11224-A. Tab-style mixers or mixing elements shall not be allowed.

2.03 ACCESSORIES:

- A. Injector Connections: Provide flanged connections with removable chemical injector quills for injection of process chemicals as listed in Table 11224-1 and as shown in the Drawings. Flanged connections shall be located on the same side of the mixer.
- B. Chemical Injector Quills: Injector configuration shall provide a single feed point to the center of each chemical pipeline. Each injector shall be a retractable injection quill with a check valve rated to 150 psi. A 1-inch main connection and 1/2-inch solution tube shall be provided for each injector. The injector length shall be such that the injector extends a distance of 1/3 of the pipe diameter unless otherwise required by the mixer manufacturer. Injectors shall be manufactured by Statiflo, or approved equal, as detailed in the Drawings.

2.04 SPARE PARTS

- A. The manufacturer shall provide a recommended spare parts list necessary to maintain the unit in operation for a period of one (1) year.

2.05 QUALITY CONTROL

- A. Perform Manufacturer's and Supplier's product quality control specifics as required for this project.

PART 3 EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

- A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations using proven construction techniques in the location shown on the Drawings.

3.03 INSPECTION AND TESTING

- A. Upon completion of installation, the Contractor, in the presence of the Engineer and a qualified manufacturer's representative, shall perform a preliminary test on the system to ensure that all component parts are functioning to the satisfaction of the Engineer.
- B. Approval of the preliminary test by the Engineer shall not constitute final acceptance of the equipment furnished.
- C. After the system is in full operation, a full operating test shall be performed in the presence of the Engineer and a qualified manufacturer's representative. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment and supervise the Start-Up Demonstration and Testing as specified in Division 01. The services of the factory representative shall be furnished for one (1) day. With the permission of the Owner these services may be combined with those provided under Paragraph 1.04 of this Section.

3.04 START-UP AND INSTRUCTION

- A. Submit to the Engineer and Owner completed checkout forms and certification of completed demonstration and training forms per Division 01. Start-up and commissioning shall not begin until all required forms are complete and all manufacturer's exceptions have been resolved by the Contractor.
- B. Furnish services of manufacturer's technical representative to inspect the completed installation, correct or supervise correction of any defects or malfunctions, and instruct operating personnel in proper operating and maintenance procedures as described in this section.

END OF SECTION

TABLE 11224-A**STATIC MIXER UNIT DESIGN REQUIREMENTS**

Item/ Design Conditions	Neut. Caustic, Sodium Hypochlorite, and Ammonia
Equipment Tag:	TBD
Mixer Finish:	316L SST
Mixer Type:	Conventional Style
Diameter:	6 inch
Design Working Pressure:	10 psi
End Connections:	ANSI 150# Class FLG
Design Water Rate of Flow, Min/Max:	350 gpm
Maximum Length:	≤6 feet
Maximum Pressure Loss at Maximum Flow:	2.7 psi
Percent Mixing Efficiency (Coefficient of Variation)	95% (0.05)

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SECTION 11241

CHEMICAL FEED SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope of Work:

Furnish all labor, materials, equipment and incidentals required and install complete, ready for operation, and field test the chemical feed systems as shown on the Drawings and as specified herein.

B. Related Work Described Elsewhere:

1. All chemical feed equipment including pumps, membrane treatment units, membrane cleaning systems, mixers and static mixers are located in Division 11.
2. Chemical storage tanks are included under Division 13.
3. Process instrumentation and controls are included under Division 13.
4. Mechanical piping, valves, pipe hangers, accessories and appurtenances are included under Division 15.
5. Electrical work is included under Division 16.

C. General Design:

1. General:

- a. The chemical feed systems specified herein are intended to support the operation of Goodland Pump Station at a finished water production capacity of 2.0 MGD. The chemical feed pump systems have each been designed with a minimum of one (1) redundant pump for system reliability.
- b. The chemical properties and materials of construction are outlined in Table 11241-A.

2. Chemical Feed Systems:

a. System Operations (Sodium Hypochlorite):

Sodium hypochlorite will be added to the influent water. Sodium hyhypochlorite, 10% solution, will be delivered to the site in truckloads and stored in the interior and exterior totes. Sodium hypochlorite solution will be transferred directly into the chemical metering pumps

from the interior bulk storage tank. The sodium hypochlorite metering pumps shall be supplied by the Contractor and shall be variable speed, metering pumps, and shall automatically adjust the dosage in proportion to the water flow rate by varying the pump speed. The chemical feed system shall be capable of feeding a maximum design dosage of 2 mg/L at a process flow rate of up to 2.0 MGD.

b. System Operations (Caustic):

Caustic will be added to the purified water. Caustic, 25% solution, will be delivered to the site in truckloads and stored in the interior and exterior totes. Caustic solution will be transferred directly into the chemical metering pumps from the interior tote. The caustic metering pumps shall be supplied by the Contractor and shall be variable speed, metering pumps, and shall automatically adjust the dosage in proportion to the purified water flow rate by varying the pump speed. The chemical feed system shall be capable of feeding a maximum design dosage of 3 mg/L at a process flow rate of up to 2.0 MGD

1.02 QUALITY ASSURANCE

- A. The chemical feed systems specified herein shall be supplied by equipment manufacturers having experience in the design and manufacture of equipment of similar size and capacity and shall present proof of successful operations involving each piece of equipment operating under similar conditions.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Submit to the Engineer for approval, as provided in the Division 01: Shop Drawings, Working Drawings and Samples, operating and maintenance manuals, systems piping and wiring diagrams, and other descriptive material for all equipment to be furnished under this Section. In addition to the information above, the submittals shall include at least the following items to demonstrate conformance of materials:
 - a. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 61.
 - b. Documentation showing product certification to NSF International Standard 61 by an ANSI accredited third-party certification body.

B. Additional Information:

1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Instructions:

1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required catalogue cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Division 01.
2. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3-EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage and handling of products shall be as specified in Division 01.

1.06 WARRANTY AND GUARANTEES

- A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Division 01. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

PART 2 PRODUCTS

2.01 GENERAL

- A. These Specifications are intended to give a general description of what is required, but do not cover details of construction which may vary in accordance with the exact requirements of the equipment as offered. They are, however, intended to include the furnishing, shop testing, delivery, installation, supervision, and field testing of all materials, equipment and appurtenances for the chemical feed equipment as herein specified, whether specifically mentioned in these Specifications or not. Also included in these Specifications is the instruction of the regular operating personnel in the care, operation and maintenance of all equipment.
- B. All necessary accessory equipment and auxiliaries required for the proper functioning of the chemical feed system installation incorporating the highest degree of standards for the specified type of service shall be furnished by the system supplier whether or not specifically mentioned in these Specifications or shown on the Drawings.
- C. All chemicals will be NSF 60 product certified.

2.02 MATERIALS AND EQUIPMENT

A. Chemical Feed Systems:

1. Chemical Storage Tank:

- a. The Contractor shall provide four (4) chemical totes, equipment numbers TBD 1, TBD 2, TBD 3, and TBD 4 for installation in the bulk chemical storage containment area as shown on the Drawings.

2. Chemical Metering Pumps:

- a. The Contractor shall furnish and install chemical metering pumps, equipment numbers TBD 1 and TBD 2 and accessories as shown on the Drawings and as specified in Section 11245: Chemical Metering Pumps.

2.03 ACCESSORIES

A. Emergency Shower and Eyewash:

1. All stainless steel, free-standing combination eye-wash and drench showers shall be provided and located as shown on the Drawings. The free standing emergency shower and eye wash stations shall be as specified in Section 15400: Plumbing System.

B. Static Mixers:

1. The Contractor shall provide all static mixers at the following locations as shown on the Drawings and as specified in Section 11224: In-Line Static Mixers.

2.04 SPARE PARTS

- A. The manufacturer shall provide a recommended spare parts list necessary to maintain the unit in operation for a period of one (1) year.

- B. Any tools and spare parts furnished by the manufacturer shall be in containers clearly identified with indelible markings as to their contents and referenced to the chemical feed system below:

1. Sodium Hypochlorite System.
2. Caustic System

Each container shall be packed with its contents protected for storage. All tools shall be furnished in steel tool boxes.

2.05 MONITORING AND CONTROL

- A. The supplier of equipment under this section is responsible for coordinating with the I&C System Supplier to ensure that its equipment is compatible with and provides all

necessary ancillary and accessory equipment to accept control signals provided by the SCADA system and provide monitoring and feedback signals to the SCADA system that are listed in Section 13410, Table 13410-1 for this equipment. This shall include all equipment control switches, flow detection switches, motor winding temperature switches and position switches that are mounted on or adjacent to the equipment for monitoring the performance of that piece of equipment. This shall also include all relays, transmitters, dry contacts and termination switches that are required on, adjacent to or in control panels supplied by the equipment vendor that are necessary to interface with the PLC/SCADA control system.

PART 3 EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

- A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required lubricants for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

3.03 INSPECTION AND TESTING

- A. Submit to the Engineer and Owner completed checkout forms and certification of completed demonstration and training forms per Division 01. Start-up and commissioning shall not begin until all required forms are complete and all manufacturer's exceptions have been resolved by the Contractor.
- B. Furnish the services of a factory representative who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise test runs of the equipment.
- C. Upon completion of installation, the manufacturer, in the presence of the Engineer, shall perform a preliminary test (no chemicals) over the full range of each system to insure the functioning of all component parts to the satisfaction of the Engineer. The test shall be over the full range of capacity. The manufacturer shall furnish all labor and equipment. Power shall be supplied by the Contractor. Approval of the preliminary test by the Engineer shall not constitute final acceptance of the equipment furnished.
- D. After the plant is in operation, a full operating test shall be performed in the presence of the Engineer and a qualified manufacturer's representative on the system. The manufacturer shall furnish all labor, materials and equipment required for such tests and shall correct any deficiencies noted by repairing or replacing the defective component and retesting as required until the equipment meets the Specifications and the satisfaction of the Engineer. The manufacturer shall have 30 days to make the changes necessary to meet the Specifications. If after said 30 day period all deficiencies have not been satisfactorily corrected, the Owner may order the manufacturer to

remove the equipment from the installation and refund to the Owner all payments made to him. Chemicals for the full operating test will be furnished by the Owner.

TABLE 11241-A
CHEMICAL PROPERTIES TABLE

Chemical Name	Formula	Average Solution Strength	Specific Gravity	Materials of Construction			
				Piping	Valves	Elast.	Hardware
Sodium Hydroxide	NaOH	25%	1.53	PVC	PVC	EPDM	316 SST
Sodium Hypochlorite	NaOCl	12.5%	1.16	PVC	PVC	Viton	Hast. C-276

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SECTION 11245

CHEMICAL METERING PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. This section covers the furnishing of all labor, materials, equipment, accessories, and incidentals required and installation, placing in operation, and field testing of the packaged chemical feed systems, chemical metering pumps, motors, controls, and accessories as specified under Section 11241: Chemical Feed Systems as further specified herein and as shown on the Drawings. Chemical feed pumps shall be furnished as part of a complete, prefabricated and pre-assembled skid offered by a reputable chemical metering skid manufacturer.
2. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the specific equipment application. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation of all materials, equipment and appurtenances for the complete pumping units, controls, and accessories as specified herein, whether specifically mentioned in these Specifications or not.
3. For all skids there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

B. Related Work Described Elsewhere:

1. Section 11241: Chemical Feed Systems.
2. Instruments and control systems are detailed in Division 13.
3. Mechanical piping, valves, pipe hangers, and supports are included in their respective Section of Division 15.
4. Electrical work, except as hereinafter specified, is included in Division 16.

C. General Design:

1. A complete description of the major components and summary of the operation of each of the chemical feed systems is included in Section 11241: Chemical Feed Systems.
2. All of the equipment specified herein shall be in complete conformity with Section 11241: Chemical Feed Systems, and these Specifications. All of the equipment specified herein is intended to be new standard equipment for use in liquid chemical feed systems and shall include, but not be limited to, the following items of material and equipment:
 - a. Fabricated skid.
 - b. Mechanically actuated diaphragm metering pumps.
 - c. Electronically Actuated Diaphragm metering pumps.
 - d. Peristaltic metering pumps.
 - e. Air Operated Diaphragm metering pumps.
 - f. Calibration chambers.
 - g. Pressure relief valves.
 - h. Pulsation dampeners
 - i. Pressure gauges/transmitters.
 - j. Backpressure valves.
 - k. Inlet Strainer
 - l. Pump drive and controls.
3. All working parts of identical pumps and motors, such as bearings, check valves, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance Manuals furnished.

1.02 QUALITY ASSURANCE

- A. To assure unity of responsibility, the motors, controls, and accessories shall be furnished and coordinated by the skid manufacturer or supplier. The supplier shall assume complete responsibility for the satisfactory installation and proper operation of the entire pumping system including pumps, motors, controls, and accessories. The chemical metering pump skids shall be furnished by Blue Planet Environmental Systems, or approved equal. The diaphragm metering pumps shall be as manufactured by Prominent or approved equal. The peristaltic pumps shall be manufactured by Prominent or an approved equal. The air operated diaphragm metering pumps shall be Prominent or approved equal.

- B. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable, qualified manufacturer having long experience in the production of such pumps. The pumps furnished shall be designed, constructed, and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.
- C. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein a minimum of five (5) years.

1.03 SUBMITTALS

A. Materials and Shop Drawings.

Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of the General Conditions, Division 01: Shop Drawings, Working Drawings and Samples, and these Specifications. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions, and anchor bolt locations.
2. Descriptive literature, bulletins, and/or catalogs of each individual piece of equipment of each skid.
3. Structural drawings showing the design of the fabricated skids. Show support systems for pumps, piping, valves, and panel. Show materials of construction by ASTM reference and grade. Show sizes of members. Show welding, bolting, or other assembly arrangements.
4. Installation and arrangement drawings showing dimensions and locations of equipment on the fabricated skid. Show locations of pumps, piping, valves, pulsation dampeners, pressure gauges, calibration columns, electrical equipment, pipe, and valve supports, and panels.
5. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, linearity, and horsepower. Curves shall be submitted on 8-1/2 inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at zero stroke speed to pump capacity at specified total head.
6. Data including principal dimensions, materials and construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.
7. A complete total bill of materials of all equipment including the weights of equipment furnished.

8. A list of the manufacturer's recommended spare parts. Include gaskets, packing, diaphragms, etc. on the list. List bearings by the bearing manufacturer's numbers only.
9. Complete motor data.
10. Copies of all factory test results, if specified in PART 2 - PRODUCTS of this Section of the Specifications.
11. The recommended summer and winter grades of lubricants along with alternative references to equal products of other manufacturers.
12. Complete wiring diagrams and schematics of each control panel, controllers, control devices and operator's station furnished under this Section.
13. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, control panels, etc., including connections to work of other Sections.
14. Quality Control Submittals:
 - a. Manufacturer's Certification of Compliance demonstrating that all materials of construction that come into direct or indirect contact with the chemicals being pumped are fully compatible for the specified service.
 - b. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
 - c. Special shipping, storage and protection, and handling instructions.
 - d. Manufacturer's printed installation instructions.
 - e. Manufacturer's Certificate of Proper Installation.
 - f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
 - g. Field Performance Test Certificate.

B. Additional Information.

1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.
2. Upon receipt and review of submitted material, provide the required number of certified prints and one reproducible tracing of all Drawings as specified in Division 01: Shop Drawings, Working Drawings and Samples.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Instructions.

1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Division 01.
2. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3-EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- B. All equipment and parts must be properly protected against any damage during a prolonged storage period at the site.
- C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.
- F. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.06 WARRANTY AND GUARANTEES

- A. The manufacturer's written warranty shall be submitted for full equipment service and parts, as specified in Division 01. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

PART 2 PRODUCTS

2.01 GENERAL

- A. The pumping units required under this section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.
- B. All equipment and piping shall be rigidly and accurately anchored into position and all necessary foundation bolts, plates, nuts, and washers shall be furnished and installed. All bolts, nuts, and washers shall be of 316 stainless steel, except for the Sulfuric Acid, Sodium Hypochlorite and Hydrochloric Acid pumps and equipment which shall be Hastelloy C and the Ammonium Sulfate and Sodium Bisulfite pumps and equipment which shall be titanium.
- C. Stainless steel nameplates giving the name of the manufacturer, model number, rated capacity, speed, and any other pertinent data shall be attached to each item of equipment.
- D. A separate stainless-steel nameplate with the equipment identification number as specified herein and as shown on the Drawings shall be attached to each item of equipment in an easily visible location. The lettering shall be stamped on using 1/4 inch high or larger letters.
- E. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes, and other pertinent data shall be attached to each motor.
- F. Engraved laminated nameplates giving the name and function of all selector switches, pushbuttons, alarm lights and control devices shall be securely attached to each panel furnished.
- G. All electrical materials and equipment shall be Underwriters Laboratories, Inc. listed and shall otherwise be equal to those specified under Division 16: Electrical.

2.02 MATERIALS AND EQUIPMENT

- A. Fabricated Skid:
 - 1. Skid shall be fabricated Polypopylene (PP) or Polyethylene (PE). Provide reinforcing guessets inside the superstructure, beneath the deck, to provide increased stiffness.
 - 2. Fasteners shall be Type 316 stainless steel except for the Hydrochloric Acid, Sodium Hypochlorite, and Sulfuric Acid pumps and equipment which shall be Hastelloy C and the Ammonium Sulfate and Sodium Bisulfite pumps and equipment which shall be titanium.

3. Skids shall be provided with containment within the skid deck to catch small spills or leaks. Containment shall have drain valve for draining of any spills or leaks.
4. Skids shall be equipped with clear plexiglass spray shields. Spray shields located on the fronts of the skid shall be hinged type with open top. Spray shields shall include cutouts for piping as required by the manufacturer. Spray shields located on the side of the skid shall be of the removable type and shall include handles, as necessary. The design of the spray shield shall be such that the shield can be removed without the removal of bolts. The spray shields shall have all appropriate supports as required by the manufacturer. Vertical support members for spray shields shall be designed so that skid accessibility is not compromised and so that the opening of hinged shield does not interfere with other equipment in the chemical room.

B. Metering Pumps - Mechanically Actuated:

1. The chemical metering pumps shall be of the single diaphragm design with the diaphragm actuated and balanced mechanically. The pump, motor, gear reducer, and stroke controller, where required, shall be mounted on a common baseplate.
2. Mechanically actuated diaphragm metering pumps shall be capable of a turndown ration of 500:1.
3. Mechanically actuated pumps shall include integral motor, oil-lubricated gear reducers. All drive components shall be oil lubricated. The liquid end shall be physically separated from the drive unit by a separate chamber behind the diaphragm created an air gap.
4. Pump shall be provided with precise seating, suction, and discharge ball check valves. The check valves shall be removable from the liquid end for servicing or replacement. The suction and discharge check valve cartridges or seats and element shall be easily field replaceable. Check valves shall be single or double ball, in line (straight-through) type check valves. No spring-loaded check valves will be acceptable. All check valve components shall be compatible with the materials to be pumped as listed in Table 11245-A.
5. The diaphragm shall be supported on each side by contour plates. The diaphragm materials shall be compatible with the materials to be pumped as listed in Table 11245-A. The pump shall be capable of a 2-foot suction lift based on water at 70°F.

6. The pumps shall have a steady state flow accuracy of within ± 1 percent over the turndown ratio. Flow repeatability shall be within ± 3 percent over the turndown ratio. Deviation from linearity shall not exceed ± 3 percent over the turndown ratio. The pumps shall be capable of accepting manual or electric control, either factory mounted or by field conversion. Pumps shall be provided with manual 0-100 percent stroke adjustment via a unit mounted micrometer unless an automatic stroke adjustment mechanism is specified in Table 11245-A. The manual stroke adjustment shall be capable of being performed while the pump is operating or idle.
7. Materials of construction for the pumping units shall be compatible with the fluids to be pumped and as listed in Table 11245-A.
8. Motor and Control:
 - a. Each mechanically actuated diaphragm pump shall be driven by an integrally mounted AC motor.
 - b. Motors shall be standard enclosed fan cooled (TEFC) or total enclosed non-ventilated (TENV) AC units and of the frame size selected by the manufacturer to prevent overheating when continuously operated at 10 percent speed and constant torque loaded. Drives shall be suitable for continuous operation over a 20 to 1 speed range within plus or minus 2 percent of selected operating speed. Each pump and drive including coupling and guard shall be factory mounted on a common base and tested. Motor shall be inverter duty rated for variable frequency drive application.
 - c. A thermal switch shall be furnished in each drive motor and wired under Division 16: Electrical to stop motor on high winding temperature.
 - d. The metering pump motor speed shall be controlled by self-contained variable frequency drive (VFD). The VFD shall be integrated at the pump.
 - e. The pump controller shall accept an analog signal such that stroke frequency is proportional to a 4-20 mA signal. The pump controller shall be capable of control through the remote signal or manually at the controller.
 - f. Electronic Stroke Control:
 - 1) Each chemical feed pump shall be equipped with an electronic stroke controller if scheduled herein under Table 11245-A. The electronic stroke controller shall automatically adjust the stroke length of the pump in response to a 4 to 20 mA analog signal as specified under Instrumentation. The control system shall be constructed to completely isolate the control signal from the AC power supply.

- 2) The stroke controller including AC synchronous drive motor and control circuitry shall be enclosed in a NEMA 4 watertight enclosure suitable for mounting on the chemical feed pump. The drive motor shall operate off of 115-volt, 60 Hz, single phase AC power. The design shall allow the system to operate under continuous stall or without signal without damage to the drive motor or control circuitry. The response time for 0 to 100% change shall be 15 seconds or less. The system shall provide a 1 to 10% dead band adjustment. The actuator shall consist of a fully enclosed cog belt coupled to a high-quality, vernier-type adjustment with lock to permit manual mechanical override and readout in the event of signal equipment malfunction.
- 3) The stroke controller shall provide for over-signal protection and programmable signal loss protection. An integral dip switch shall allow the operator to program the controller to either freeze the stroke length at the last position or drive to zero in the event of a control signal loss.

C. Metering Pumps - Electronically Actuated:

1. Chemical metering pumps shall be positive displacement non-hydraulic, solenoid driven, diaphragm type pumps. Output shall be "hot" rated (at operating temperature) and shall be adjustable while pumps are in operation. Positive flow shall be ensured by a minimum of four ball type check valves. A bleed valve shall be provided for the manual evacuation of entrapped air or vapors and safe relief of pressure in the discharge line.
2. To prevent damage to pump from overheating, the solenoid shall have automatic reset thermal overload protection. For overpressure conditions, pump shall automatically stop pulsating when discharge pressure exceeds pump pressure rating by not more than 35% when pump is set at maximum stroke.
3. Pump drive shall be encased in a water-resistant housing constructed of a chemically resistant glass filled polyester. The electronic circuitry shall be mounted at the rear of the pump for maximum protection against chemical intrusion.
4. Materials of construction for the pumping units shall be compatible with the fluids to be pumped and as listed in Table 11245-A.

D. Metering Pumps – Air Operated Diaphragm:

1. The air operated metering pumps shall be air operated, sealless positive displacement pumps that compress fluid by increasing and decreasing the volume of a chamber containing the fluid. Two diaphragms shall be pneumatically oscillated (pressurized and exhausted) to displace the liquid. The pumps shall utilize a solenoid valve to initiate operation of pumps through the air supply. Provide check valves on both the suction inlets and discharge outlets. Pumps shall be suitable for pumping the specified liquids in Table 11245-A.
2. Provide a double-diaphragm design in which an air valve alternates air supply to the diaphragms.
3. Design the pump cover per ASME Boiler and Pressure Vessel code, Section VIII, for a 1,000-psi operating pressure.
4. Pump materials of construction shall be as noted in Table 11245-A.
5. Solenoid Valve:
 - a. Provide solenoid-operated three-way valve to admit and release air to move the pump diaphragm. Valve shall be normally closed. Provide internal valves to actuate the main valve poppets which control the port openings. Enclosures shall be NEMA 4.
 - b. Solenoid valve shall provide N.O. contacts (closed to indicate signal) to indicate the following:
 - 1) Solenoid in closed position.
 - 2) Solenoid fault.
6. Check Valves:
 - a. Check valves on the pump suction inlet and discharge outlet shall be of the flapper or ball type. Provide elastomer sealing disc on the check valve.
7. Filter Regulator Lubricator Assembly:
 - a. Provide a modular filter, pressure regulator, lubricator assembly (FRL) for each pump. Modular FRL assembly shall consist of an air filter, pressure regulator and lubricator. Install FRL on the air piping upstream of the pump. FRL shall be Master Pneumatic Sentry Modular Series, or equal.

E. Metering Pumps – Peristaltic:

1. Pumps shall be positive displacement peristaltic type complete with spring-loaded pump head, self-contained variable speed drive, and flexible extruded tube as specified.

2. Peristaltic pumping action shall be created by the compression of the flexible tube between the pump head rollers and track, induced forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum creating restitution of the tube.
3. Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube and shall have a maximum suction lift capability of up to 30 feet vertical water column. Maximum pressure rating shall be 50 psi.
4. Pump shall not require the use of check valves or diaphragms and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within the pump tubing and shall not directly contact any rotary or metallic components.
5. Flow shall be in the direction of the rotor rotation, which can be reversed and shall be proportional to rotor speed.
6. Pump Head:
 - a. Pump head shall consist of a fixed track, a hinged guard door, and spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing backflow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate 2.4 mm wall thickness tubing and shall not require adjustment.
 - b. Pump head guard shall be transparent for the purpose of viewing direction of rotation. When closed, the pump head guard shall seal against the pump track for leak containment and controlled waste through the pump head waste port in the event of a tube failure. Pumps in which the direction of rotation cannot be visually verified and/or do not have a controlled waste port are not acceptable.
 - c. Pump Head Assembly:
 - 1) Pump track geometry must have a minimum 96.6 mm swept diameter through a minimum track angle of 180°.
 - 2) Provide high corrosion/impact materials as specified.
 - a) Track Construction: Polyphenylene sulfide (PPS).
 - b) Guard Construction: Hinged impact-resistant polycarbonate breakaway guard, tool un-lockable for operator safety.
 - c) Rotor Construction: Polyphenylene sulfide (PPS).
 - d. Rotor Assembly:
 - 1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:

- a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution. Compressing rollers shall be of Type 316 stainless steel with low friction stainless steel bearings and PTFE seals, minimum diameter of 18 mm.
- b) Provide non-compressing guide rollers constructed of corrosion resistant Nylatron.
- 2) Clutch: Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch shall automatically reengage rotor to gearbox upon one complete revolution.
- 3) Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gear motor via a slotted collet and central retaining screw.
- 4) Pump heads requiring disassembly or special tools for tube changing are not acceptable.

7. Tubing:

- a. Pump shall be supplied with a Load Sure tubing element with molded fittings, which shall be self-locating when fitted into the pump head. Tube element shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by the element fittings. The tubing shall be replaceable without the use of tools and with no disassembly of the pump head.
- b. Load Sure element shall be constructed with tubing material specified in Table 11245-A with male PVDF quick-release connectors.
- c. Supply one (1) tube element of the specified size per pump.
- d. Supply two (2) one-meter-long flexible reinforced PVC hoses for connection of pump to suction and discharge process lines. Flexible hose shall have a PVDF female quick-release fitting for connection to the Load Sure element and male quick-release fitting for connection to NPT adaptor with built in shut-off valve for ease of maintenance and connection to process lines.
- e. Supply two (2) quick release to NPT Adaptors.

8. Drive:

- a. Rating: Continuous 24-hour operation, 40 degrees C ambient.
- b. Supply: 120VAC single-phase. Supply nine-foot length power cord with standard three-prong plug.
- c. Enclosure: NEMA 4X.
- d. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. Unpainted housings are not acceptable.

- e. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.
- 1) Backlit graphical LCD capable of up to four lines of text with up to 16 characters per line to display pump speed, running status, flow rate, and programming instructions.
 - 2) Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
 - 3) Menu driven on screen programming of manual or automatic control, flow and remote signal calibration, and general programming.
 - 4) Programmable "auto restart" feature to resume pump status in the event of power interruption.
 - 5) Programmable "keypad lock" to allow operator lockout of all keys except emergency start/stop.
 - 6) Programmable "maximum speed" to allow operator to set the maximum speed of the pump within 0.1-220 rpm.
- f. Supply automatic control features to meet the following minimum functionality requirements for use with the SCADA system. All control signal features must be located internally to the pump. Pumps not meeting this minimum functionality or that require additional external control boxes are not acceptable.
- 1) Remote Control Inputs:
 - a) Speed Control:
 - Primary analog 4-20 mA DC trimmable speed input, with input signal and speed scaleable over any part of the drive speed range.
 - Secondary analog 4-20 mA DC scaling input, with input signal trimmable and programmable scaling factor.
 - Provisions for alternative remote accessory potentiometer (if supplied by others) for primary speed control or secondary speed scaling.
 - b) Start/Stop Control: Via 5V TTL, 24V industrial logic or dry contact. Configurable command sense allowing open to equal run or open to equal stopped.
 - c) Forward/Reverse Control: Via 5V TTL, 24V industrial logic or dry contact.
 - d) Auto/Manual Mode Control: Via 5V TTL, 24V industrial logic or dry contact.
 - e) Leak Detector Run/Stop Control: Via 5V TTL, 24V industrial logic, or dry contact.
 - 2) Status Outputs:
 - a) Four relay contacts rated for a 30 VDC with a maximum load of 30W, NO or NC software configurable to indicate the following:
 - Running/Stopped status.

- Forward/Reverse status.
 - Auto/Manual status.
 - General Alarm status.
 - Leak Detected status.
- b) Speed Output: Analog 4-20mA DC.
- 3) Termination: Supply screw down terminals suitable for up to 18 AWG field wire and accessible through four glanded cable entry points on the pump.
- g. Drive Motor: Brushless DC motor with integral gearbox and tachometer feedback.
- 1) Speed control range of 2200: 1 from 0.1 to 220 rpm +/- 0.1 rpm throughout the range.
- 2) Closed loop microprocessor-controlled drive with pulse width modulation at speeds above 35 rpm and synchronous mode with magnetic field rotation control below 35 rpm.
- 3) Circuitries complete with temperature and load compensation and protection.
- h. Mounting: Drive shall be self-supporting and shall not require anchoring.
- i. Leak Detection: Pump manufacturer shall supply float-type leak sensor mounted to the drain port of the pump head for leak detection and pump shut down in the event of a tubing failure.

F. Nameplates:

1. Each pump shall be equipped with a stainless-steel nameplate, indicating equipment characteristics, pump capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, and serial number.

2.03 ACCESSORIES

A. Pressure Relief Valves:

1. Pressure relief valves shall be provided on the discharge header of each chemical feed system as shown on the Drawings. Pressure relief valves shall use a diaphragm design and be externally adjustable by means of a screwdriver. All materials of construction shall be compatible with, and fully resistant to corrosion by the liquids being pumped. The size shall match the associated metering pump capacity.

B. Backpressure Valves:

1. Backpressure valves shall be provided on the discharge headers of the chemical feed systems as shown on the Drawings. Backpressure valves shall use a diaphragm design and be externally adjustable by means of a screwdriver. All materials of construction shall be compatible with, and fully resistant to corrosion by the liquids being pumped. The size shall match the associated metering pump capacity.

C. Pulsation Dampeners:

1. Pulsation dampeners shall be provided for installation on the discharge piping of each metering pump as shown in the Drawings. Pulsation dampeners shall provide for a volumetric residual fluctuation of ± 4 percent or less based upon a single feed pump in operation. The pulsation dampeners shall be equipped with a pressure gauge and charging valve mounted on top of the gas chamber. All materials of construction shall be compatible with and fully resistant to corrosion by the liquids being pumped. Pulsation dampeners shall be supplied by the pump manufacturer.

D. Calibration Columns:

1. Provide transparent calibration chambers to be mounted on the suction piping of each chemical feed system. The calibration columns shall be supplied with flanges on each end with NPT taps for connection of piping. The flanges shall be gray PVC for acrylic or clear PVC columns and stainless steel or fiberglass with Viton O-ring seals for glass columns. Glass columns shall be provided with stainless steel tie rods for structural stability. The calibration columns shall be as manufactured by Griffco or approved equal. The calibration column shall be sized such that a measurable capacity of the chamber is at least 1 minute discharge of each pump at maximum pumping capacity.

E. Pressure Gauges:

1. Pressure gauges shall be provided on the discharge header of metering pumps as shown in the Contract Drawings. Each gauge shall have a range of 0 to 100 psi or the maximum working pressure of the pump plus 25 psi. Gauges shall have a PVC diaphragm seal (CPVC for Sulfuric Acid and stainless steel for Sodium Bisulfide) and shutoff valve. Shutoff valves shall be of the same material as the piping with seals that are resistant to the chemical applications.

F. Electrical Termination Junction Box:

1. Provide skid mounted NEMA 4X FRP power supply terminal junction box (TJB) and control/signal terminal junction box for each skid. Power supply TJB shall be suitable for accepting a single point external 120VAC, 1-phase, 60-Hz power supply connection. Division 16 shall provide and install a local disconnect near each skid. Skid supplier shall distribute power from this TJB to associated skid mounted individual pumps. The power cord of every pump on the skid shall be terminated in the power supply box. All control and signals wires shall be prewired to the control/signal TJB. Termination box shall be sized in accordance with NEC requirements and shall contain appropriate terminal strips for skid mounted wiring and external wiring.
2. See drawings for input and output signals and alarms. Furnish complete wiring diagrams for all terminal boxes mounted on the skid. Clearly identify customer connection points for all external wiring for proper system operation.

G. Wiring and Conduit within the Skid or Base:

1. Wiring for power and control circuits shall be sized and installed per the NEC.
2. Color-code control wiring in switching and control assemblies per ICEA Method 1, NEC applications, Option A. Jacket shall be black PVC. Lay out conductors neatly so they may be followed by eye from one terminal to another. Wiring shall be vertical or horizontal. Color-coding shall be such that electrically common interconnections of devices are the same color. The colors may be used more than once but not in the same circuit or cable grouping.
3. Power and control cable shall be copper, insulated for 600 volts, 75°C wet and 90°C dry locations, UL Type THWN or XHHW. Insulation jacket shall be nylon. Install bare or green insulated copper conductors in power circuits for grounding connections. The cable shall meet the requirements of UL 83.

2.04 SPARE PARTS

- A. All special tools required for normal operation and maintenance of the equipment shall be furnished with the equipment by the manufacturer.
- B. The following spare parts shall be furnished for the mechanically actuated metering pumps:
 1. Two (2) extra sets of all gaskets, seals, diaphragms, packing, etc. of each different type.
 2. One (1) box of fuses of each size furnished.
 3. One (1) box of pilot lights.
 4. One (1) control power transformer.
 5. One (1) container of each type of lubricating or hydraulic oil required.
- C. The following spare parts shall be furnished for the peristaltic metering pumps:
 1. One (1) spare pump head assembly and rotor for each size pump.
 2. One (1) spare hose (tubing) with appropriate connectors per pump.
- D. The Manufacturer shall recommend and supply all spare parts in addition to the aforementioned necessary for the first five (5) years of operation. Spare parts shall be marked with parts numbers and packed in suitable containers also marked with the part numbers.
- E. All tools and spare parts shall be furnished in containers clearly identified with indelible markings as to their contents. Each container shall be packed with its contents protected for storage. All tools shall be furnished in steel toolboxes.

PART 3 EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

- A. Installation of the pumps, drivers, and accessories shall be in strict accordance with the manufacturer's instructions and recommendations in the location shown on the Drawings. Installation shall include furnishing the required lubricants for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

3.03 INSPECTION AND TESTING

- A. Furnish the services of a factory representative who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise test runs of the equipment.
- B. Upon completion of installation, the manufacturer, in the presence of the Engineer and Owner, shall perform a preliminary test of the complete chemical feed system as specified under Section 11241: Chemical Feed Systems.

3.04 START-UP AND INSTRUCTION

- A. Submit to the Engineer and Owner completed checkout forms and certification of completed demonstration and training forms per Division 01. Start-up and commissioning shall not begin until all required forms are complete, and all manufacturer's exceptions have been resolved by the Contractor.
- B. Contractor shall furnish at his expense the services of a factory-trained service engineer for system start-up, calibration, and instruction briefings for operating personnel. Service shall be furnished for a minimum of six (6) working days with additional time furnished if required to correct problems or deficiencies.
- C. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 2 person-days for installation assistance and inspection.
 - 2. 3 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1/2 person-day for prestart up classroom or site training.
 - 4. 1/2 person-day for facility startup.

**TABLE 11245-A
FEED PUMP DESIGN REQUIREMENTS**

Item	Caustic Feed System	Sodium Hydroxide Feed System
Equipment Numbers	TBD	TBD
Type	Metering Pump	2
Number of Units	2	2
Design Capacity (Each)	0.8 gph	1.50 gph
Min. Operating Pressure Design Capacity (Each)	50 psi	50 psi
Min. Operating Pressure	100 psi	100 psi
Power Requirements Min. Operating Pressure	½ hp	½ hp
Power Requirements	¼ hp	¼ hp

END OF SECTION

SECTION 15090

CHEMICAL FEED SYSTEM PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope or Work:

1. This section covers furnishing and installation of piping and piping accessories and chemical feed piping including secondary containment casing piping, primary carrier piping/tubing, fittings, and appurtenances as specified herein.
2. Piping shall be furnished and installed complete with all fittings, jointing materials, hangers, supports, anchors, and other necessary appurtenances.
3. Material furnished and work performed under this Section shall be coordinated with material and equipment furnished and installed in Section 11241, Chemical Feed Systems.
4. Chemical containment piping systems consisting of an inner primary carrier pipe/tubing, contained within a secondary outer containment casing pipe, are required for all chemical feed lines, unless otherwise shown in the Drawings.

B. Related Work Described Elsewhere: Other sections directly related to work covered in this section include the following:

1. Piping, Valve, and Equipment Identification System: Section 09905.
2. High Performance Paints and Coatings: Section 09961.
3. Division 15.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. Polyvinyl Chloride (PVC) Pipe: As specified in Section 15070.
2. Chlorinated Polyvinyl Chloride (CPVC) Pipe: As specified in Section 15072.
3. Stainless Steel Pipe: As specified in Section 15066.
4. Double Wall Containment Piping System: As specified in Section 15076.

- B. Solvent welder shall be qualified in accordance with Chapter VII of the ASME B31.3-93 Code, Part 9, Paragraph A328.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

- 1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Division 01. All products within this specification shall be combined into a single submittal which shall include at least the following:
 - a. Dimensioning, complete technical specifications, data, and catalog cuts or drawings for all PVC chemical feed piping and fittings including flexible carrier tubing, containment casing pipe, and appurtenances including, but not limited to, expansion joints for PVC pipe, flange gaskets, pipe sleeves, and pipe supports to be furnished.
 - b. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

B. Additional Information:

- 1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

1.04 OPERATIONS AND MAINTENANCE DATA

- A. Operating and Maintenance Manual: Furnish Operation and Maintenance Manuals in accordance with Division 01.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Pipe and fittings shall be handled and stored in a manner which will ensure installation in sound, undamaged condition. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide padded skids. Whenever the storage period on the job exceeds 30 days, plastic pipe shall be covered or otherwise protected from exposure to sunlight.
- B. Chemical feed system pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible, pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a fork lift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.

- C. Should chemical feed system pipe or tubing be stored for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. Any double wall containment pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.
- D. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging, or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe.

1.06 WARRANTY AND GUARANTEES

- A. Provide equipment warranty in accordance with Division 01.

PART 2 PRODUCTS

2.01 GENERAL

- A. Chemical feed system pipe shall be installed in the locations as shown on the Drawings. All semi-rigid tubing, plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.

2.02 MATERIALS AND EQUIPMENT

- A. Rigid PVC Pipe and Fittings:
 - 1. Materials for Schedule 80 PVC pipe and fittings shall be as specified in Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings.
 - 2. Joints and jointings shall be as specified in Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings.
- B. Rigid CPVC Pipe and Fittings:
 - 1. Materials for CPVC pipe and fittings shall be as specified in Section 15072: Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings.
 - 2. Joints and jointings shall be as specified in Section 15072: Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings.
- C. Stainless Steel Pipe, Tubing and Fittings:

1. Materials for stainless steel pipe, tubing and fittings shall be as specified in Section 15066: Type 316 Stainless Steel Pipe and Fittings.
 2. Joints and jointings shall be as specified in Section 15066: Type Stainless Steel Pipe and Fittings.
- D. Containment Casing Pipe for Buried Chemical Feed Lines
1. Sizing: Each containment casing pipe shall be sized to allow installation of carrier tubing.
 2. Unless noted otherwise, containment casing piping shall be Schedule 40 PVC conforming to ASTM D1785.
 3. Use only long sweep elbows for bends greater than 45-degrees, or a combination of two (2) 45-degree fittings to provide a bend radius that is double the minimum allowable carrier tubing bend radius. Fittings for Schedule 40 pipe shall be socket type, solvent welded in conformance with ASTM D2855. Solvent welded joints shall be watertight.
 4. Pull boxes: Provide chemical pull boxes at each pull station for buried piping as detailed in the Drawings.
- E. Double Wall Containment Pipe & Fitting Systems:
1. Materials for Double Wall Containment pipe and fittings shall be as specified in Section 15076: Double Wall Containment Piping Systems.
 2. Joints and jointings shall be as specified in Section 15076: Double Wall Containment Piping Systems.
- F. Semi-rigid Carrier Tubing:
1. Materials for semi-rigid carrier tubing and fittings shall be as specified in Section 15076: Double Wall Containment Piping Systems.
- G. Piping Schedule:
1. Refer to Piping Schedule in the Drawings for the materials to be used on each piping system, the conditions of service and hydrostatic testing requirements.
- H. Fabrication and Manufacture:
1. A union shall be provided within 2 feet of each threaded end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping at locations adjacent to devices or equipment which may require removal in the future and at locations required by the drawings or specifications.

2. Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a shutoff gauge cock.
3. Pipe hangers and supports shall be provided as specified in Section 15126: Hangers and Supports.

I. Vented Ball Valves for Sodium Hypochlorite Service:

Provide PVC vented ball valves for sodium hypochlorite service. 2.04

QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.
2. All chemical feed piping shall have sufficient number of unions to allow convenient removal.
3. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed.
4. All valves and equipment shall be supported independently from the pipe. Anchor valves such that the turning moment resulting from their operation will not be transmitted to the pipe.

B. Pipe:

1. Pipe shall be installed as specified, as indicated on the drawings or, in the absence of detail piping arrangement, in a manner acceptable to the Engineer.
2. Pipe shall be cut from measurements taken at the site and not from the drawings. All necessary provisions shall be taken in laying out piping to provide for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction so as not transmit noise resulting from expansion.
3. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation and testing.

4. All piping shall be installed so that lines are readily accessible for cleaning. At changes in direction in all chemical piping, tees shall be provided with extra openings plugged to facilitate cleaning. Teflon thread tape or teflon thread sealer shall be applied to the threads of all plugs so that they can be easily removed. At each point where plastic tubing is connected to rigid piping, an adapter coupling shall be provided.
- C. Pipe Joints: Pipe joints shall be carefully and neatly made in accordance with the requirements which follows.
1. Threaded:
 - a. Pipe threads shall conform to ANSI 82.1, NPT, and shall be full and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed, after threading and before assembly, to remove all burrs.
 - b. Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads.
 2. Solvent Welded: All joint preparation, cutting and jointing operations shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the set time recommended by the manufacturer. Pressure testing of solvent welded piping systems shall not be performed until the applicable curing time, set forth in Table X2.1 of ASTM D2855, has elapsed.
 3. Flanged: Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but not so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.
- D. Pipe Sleeves:
1. Piping passing through or below concrete or masonry shall be installed through sleeves installed before the concrete is placed or when masonry is laid.
 2. Unless otherwise indicated on the drawings, all pipes passing through or below walls or slabs shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.
 3. Buried pipe sleeves enclosing chemical-piping shall be sloped to the open end as indicated on the drawings to allow observation of leakage of the chemical piping. The upper end of each sleeve shall be sealed watertight.
- E. Buried Chemical Containment Piping Systems:

1. Unless noted otherwise, chemical containment piping systems consisting of flexible carrier tubing installed within a rigid containment casing pipe shall be used for all buried chemical piping.
 2. Precast concrete pull boxes shall be provided as specified in the Drawings. The pull boxes shall be placed at every 270-degrees of piping bends (3rd 90-degree bend or equivalent) and a maximum of 280 feet along buried runs of chemical feed piping to make tubing coupling connections and to provide a means of pulling the tubing through the containment casing pipe. The precast pull boxes shall be coated with chemical resistant coating to protect the concrete from chemical attack in the event of a leak. The concrete pull boxes shall have water-tight aluminum hatches as shown in Drawings.
 3. Buried containment casing pipe shall be installed to slope continuously between pull boxes without dips and valleys so that leaks will drain to the boxes. Maintain minimum 0.2% slope of casing piping to pull boxes and/or low points.
 4. Flexible carrier tubing sections shall be coupled together inside the boxes only. Tubing shall be coiled inside each box to account for expansion and contraction. Coil radius shall exceed the tubing manufacturer's recommended minimum radius.
 5. Fiberglass Reinforced Plastic pipe supports shall be used to support tubing inside pull boxes, however, coiled tubing shall be loosely secured to supports to allow longitudinal movement for expansion/contraction.
- F. Field Painting: Pipe normally exposed to view shall be painted and marked as specified in Section 09905.

3.02 INSPECTION AND TESTING

A. Pressure and Leakage Testing:

1. All specified tests shall be made by and at the expense of the Contractor in the presence, and to the satisfaction of, the Engineer. Each piping system shall be tested in accordance with Section 15044 and at a minimum, must experience no loss of pressure for at least one hour.
2. Compressed air or pressure gas shall not be used to test plastic piping unless specifically recommended by the pipe manufacturer.
3. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method acceptable to the Engineer. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

4. Drainage and venting systems shall be tested by filling with water to the level of the highest vent stack. Openings shall be plugged as necessary. Each system shall hold the water for 30 minutes without any drop in the water level.
5. All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of the Contractor and at such time as directed by the Engineer.
6. All joints in piping shall be tight and free from leaks. All joints which are found to leak by observation or during any specified test shall be repaired and tests repeated.

B. Cleaning:

1. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, dirt, and other foreign matter when erected. The interior of all lines shall be thoroughly cleaned, to the satisfaction of the Engineer, before being placed in service.
2. Lines which have been flushed with water shall be air dried with compressed air immediately following drainage.
3. Sulfuric Acid Piping
 - a. After all testing has been completed, the sulfuric acid piping shall be purged with nitrogen gas or another acceptable means to remove all traces of water and moisture from piping before acid is placed in the piping.

END OF SECTION

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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
 milliamper(s)..... 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 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.callsunshine.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 and verified by Collier County Locate Department personnel before performing work. 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 numeric pager at 239-890-0809. **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 delay or denial of permit.

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 effect 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, mars, 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 033000

CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section describes materials, mixing, testing, and placing of concrete and grout.

1.02 SUBMITTALS

- A. Submit shop drawings in accordance with the General Conditions and Section 01340 Shop Drawings, Working Drawings and Samples.
- B. Prepare concrete and mortar mix designs and laboratory 7-day and 28-day compressive tests or submit test reports of 7- and 28-day compressive tests of the mix where the same mix has been used on two previous projects. Prepare mix designs in accordance with ACI 318, Chapters 4 and 5, except as modified herein. Submit mix design in writing for review by the Owner at least 15 days before placing of any concrete.
- C. Provide certificate that cement used complies with ASTM C150 and these specifications.
- D. Provide certificates that aggregates comply with ASTM C33 and contain less than 1% asbestos by weight or volume. State weathering region limits of coarse aggregates: severe, moderate, or negligible. State basis of determining that potential reactivity is negligible. Identify certifications and tests to actual materials to be used in the work. Provide additional tests and certifications for each change in material source. Provide an alternate material source of aggregate if tests indicate that aggregates are reactive or possess severe weathering potential. Submit gradation analysis with concrete mix designs.
- E. Provide delivery tickets for ready-mix concrete or weighmasters certificate per ASTM C94, including weights of cement and each size aggregate and amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both coarse and fine aggregate.
- F. Provide certificate of compliance with these specifications from the manufacturer of the concrete admixtures.
- G. Provide epoxy bonding compound manufacturer's specific instructions for use. Provide manufacturer's certifications as to suitability of product to meet job requirements with regard to surface, pot life, set time, vertical or horizontal application, and forming restrictions.
- H. Provide nonshrink grout manufacturer's certificate of compliance with these specifications and specific instructions for use.

- I. Submit six copies of a report from a testing laboratory verifying that aggregate and gravel material contains less than 1% asbestos by weight or volume and conforms to the specified gradations and characteristics.
- J. Plant Qualification: Submit certification from the National Ready Mixed Concrete Association or FDOT indicating compliance with the specified qualification requirements.
- K. For potable water, provide certification that all materials used in grout, concrete, or the curing and repair of concrete, meet the requirements of ANSI/NSF 61 for contact with potable water.

1.03 PLANT QUALIFICATION

- A. Meet requirements of the Check List for Certification of Ready Mixed Concrete Production facilities of the National Ready Mixed Concrete Association and ASTM C94.

1.04 STANDARDS

- A. Unless otherwise indicated, materials, workmanship, and practices shall conform to the following standards:
 - 1. FBC (Latest Edition).
 - 2. ACI 301, "Structural Concrete for Buildings."
 - 3. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 4. ANSI/NSF 61: "Drinking Water System Components-Health Effects."
- B. Where provisions of pertinent codes and standards conflict with this specification, the more stringent provisions govern.

PART 2 - MATERIALS

2.01 NONDOMESTIC CEMENT AND ADDITIVES

- A. The use of nondomestic cement and additives in concrete may be permitted only after review of a written request to use such materials. The request to use nondomestic materials shall include a chemical analysis that indicates the material meets the project specifications. Certifications that state the nondomestic materials meet the project requirements will not be accepted.
- B. Test reports for concrete materials shall be current to within three months of inclusion into the project and shall be identifiable to the materials supplied.

2.02 CEMENT

- A. Unless nondomestic cement has been approved, use domestic portland cement that conforms to ASTM C150 and C595, Type IPMS or, in lieu of Type IPMS, provide a mixture of 80% Type II portland cement and 20% pozzolan fly ash II/V or 20% Class F fly ash. Use Type III cement for high early strength concrete only for special locations and only when reviewed in advance by the Resident Project Representative. Use Type I cement for tremie concrete. Pozzolan or fly ash content of Type IPMS cement shall not exceed 20% of the total weight.
- B. Use only one brand of cement in any individual structure. Use no cement that has become damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Use no salvaged or reclaimed cement.
- C. Maximum tricalcium aluminate shall not exceed 8%. The maximum percent alkalis shall not exceed 0.6%.

2.03 AGGREGATES

- A. Aggregates shall be natural rock, sand, or crushed natural rock and shall comply with ASTM C33, and shall contain less than 1% asbestos by weight or volume. Aggregates shall be free from any substances that will react with the cement alkalis, as determined by Appendix X-1 of ASTM C33.

2.04 WATER AND ICE

- A. Use water and ice that is clean and free from objectionable quantities of organic matter, alkali, salts, and other impurities that might reduce the strength, durability, or otherwise adversely affect the quality of the concrete. Water shall not contain more than 500 mg/L of chlorides nor more than 500 mg/L of sulfate.

2.05 COLOR ADDITIVE FOR EXTERIOR ELECTRICAL DUCT ENCASEMENT

- A. For exterior electrical duct concrete encasements, use a color additive for identification purposes: brick red "Colorfull" as manufactured by Owl Manufacturing Company, Arcadia, California; coral red "Chromix C-22" as manufactured by L. M. Scofield Company, Los Angeles, California; or equal. Add the color additive while the concrete is being mixed using the quantity per cubic yard of concrete recommended by the manufacturer for the class of concrete indicated.

2.06 CONCRETE ADMIXTURES

- A. Class A concrete shall contain an air-entraining admixture conforming to ASTM C260. Admixtures shall be Master Builders MB-AE 90, Sika AER, or equal.
- B. Class A concrete shall contain a water-reducing admixture conforming to ASTM C494, Type A or D. It shall be compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's

recommendations. Admixtures shall be Master Builders Pozzolith polymer-type normal setting, Plastocrete 161 or Plastiment, Sika Chemical Corporation, or equal.

- C. Do not use any admixture that contains chlorides or other corrosive elements in any concrete. Admixtures shall be nontoxic after 30 days.

2.07 FLY ASH:

- A. Provide fly ash conforming to the following requirements:
 - 1. Class F fly ash conforming to ASTM C 618 for chemical and physical properties. Flyash shall be produced from a single know and consistent source.
 - 2. The amount of flyash used shall be between 20 and 25% by weight of the specified cement weight.
 - 3. Supplemental requirements in percent:
 - a. Maximum carbon content: 3%
 - b. Maximum sulfur trioxide (SO₃) content: 4%
 - c. Maximum loss on ignition: 3%
 - d. Maximum water requirement (as a percent of control): 100%
 - e. Fineness, maximum retained on No. 325 sieve: 25%

2.08 SUPERPLASTICIZER

- A. Comply with ASTM C1017, Type 1 or 2.

2.09 NONSHRINK GROUT

- A. Nonshrink grout shall conform to the Corps of Engineers Specification for Nonshrink Grout, CRD-621-83, and to these specifications. Use a nongas-liberating type, cement base, premixed product requiring only the addition of water for the required consistency. Grout shall be UPCON High Flow, Master Flow 713, or equal. Components shall be inorganic.

2.10 ORDINARY TYPE GROUT (DRY PACK)

- A. One-part portland cement to two parts sand (100% passing a No. 8 sieve). Add sufficient water to form a damp formable consistency.

2.11 EXPANSIVE GROUT

- A. Premixed, cementitious mixture with a minimum 28-day strength of 3,500 psi. Provide air-entraining admixture as recommended by the manufacturer.

2.12 EPOXY GROUT

- A. Mix the two components of epoxy bonding compound in compliance with the manufacturer's instructions.
- B. Use sand that is oven dry and meets the following gradation requirements for epoxy grout.

Sieve Size	No. 8	No. 50	No. 100
% Passing	100	30 ±15	5 ±5

2.13 EPOXY GROUT FOR MACHINERY BASEPLATE INSTALLATION

- A. Epoxy grouts shall meet the following minimum requirements:
 - 1. Creep shall be less than 0.005 in./in. when tested per ASTM C1181. The tests shall be at 70°F and 140°F with a load of 400 psi.
 - 2. Linear shrinkage shall be less than 0.080% and thermal expansion less than 17×10^{-6} in./in./°F when tested per ASTM C531.
 - 3. Compressive strength shall be a minimum of 12,000 psi after seven days when tested per ASTM C579, Method B.
 - 4. Bond strength to portland cement concrete shall be greater than 2,000 psi when tested per ASTM C882.
 - 5. Epoxy grout shall pass the thermal compatibility test per ASTM C884 when overlayed on portland cement concrete.
 - 6. Determine tensile strength and modulus of elasticity per ASTM D638. The tensile strength shall not be less than 1,700 psi and the modulus of elasticity shall not be less than 1.8×10^6 psi.
 - 7. Determine gel time and peak exothermic temperature per ASTM D2471. Peak exothermic temperature shall not exceed 110°F when a specimen 6 inches in diameter by 12 inches high is used. Gel time shall be at least 150 minutes.
 - 8. The grout shall be suitable for supporting precision machinery subject to high impact and shock loading in industrial environments while exposed to elevated temperature as high as 150°F, with a load of 1,200 psi.
 - 9. Products: Escoweld 7505E, with 7530 aggregate, or equal.
- B. Epoxy primer shall be a lead free, chrome free, rust inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout products. Products: Escoweld 1014E Rust Inhibitive Epoxy Primer or equal.

C. Nonbonding Filler for Anchor Bolt Sleeves: Escoweld 7506 or equal.

D. Epoxy Grout Liquid: Escoweld 7502E or 7507E or equal.

2.14 JOINT MORTAR BED

A. Mortar or grout placed on horizontal construction joints shall be a mixture of cement, sand, and water in the same proportions used in the concrete but with coarse aggregate omitted.

2.15 EPOXY BONDING COMPOUND

A. Bonding compound shall be Sikadur 32 Hi-Mod, Sika Chemical Corporation, Lyndhurst, New Jersey; Concresive by BASF; Euco Epoxy 452 by Euclid Chemical Company; or equal.

2.16 NONEPOXY BONDING COMPOUND

A. Use Weldcrete by Larsen Products Corp., Link by Sta-Dry Manufacturing Corp., Euco Weld by Euclid Chemical Co., or equivalent. The compound shall be rewettable for up to two weeks.

2.17 CONCRETE MIX DESIGN

A. Conform to ASTM C94, except as modified by these specifications.

B. Air content as determined by ASTM C231 shall be 2% $\pm$ 1%.

C. Provide concrete with the following compressive strengths at 28 days and proportion it for strength and quality requirements in accordance with ACI 318, "Proportioning on the Basis of Field Experience," to achieve 28-day compressive strength as follows:

Class	Type of Work	28-Day Minimum Compressive Strength (in psi)	W/C Ratio (Max)	Cement Content (min) (in lbs per C.Y.)
A	Concrete for all structures and concrete not otherwise specified. Concrete fill at structure foundations, cradle, supports across pipe trenches.	4,500	0.42	564
B	Pavement	3,000	0.54	500
C	Floor grout, miscellaneous unreinforced concrete.	3,000	-	376
D	Precast concrete	5,000	0.40	630

- D. Measure slump in accordance with ASTM C143. Slump shall be as follows:
1. Slab on grade or heavy sections wider (in plan view) than 3 feet: 4 inches maximum.
 2. Footings, walls, suspended slabs, beams, and columns: 4 inches maximum.
 3. Pavement: 2 inches maximum.
 4. Floor grout: 4 inches maximum.
 5. Proportion and produce the concrete to have a maximum slump as shown; slump is prior to addition of superplasticizer. A tolerance of up to 1 inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.
- E. Aggregate size shall be 3/4 inch maximum for slabs and sections 8 inches thick and less. Aggregate size shall be 1 inch maximum for sections greater than 8 inches and less than 17 inches. Aggregate size shall be 1-1/2 inches maximum for all larger slabs and sections. Aggregate size for floor grout shall be maximum 3/8 inch.
- F. Combined aggregate grading shall be as shown in the following table:

	Maximum Aggregate Size			
	1-1/2"	1"	3/4"	3/8"
Aggregate Grade per ASTM C33	467	57	67	8

- G. Mix design for pumped concrete shall produce a plastic and workable mix. The percentage of sand in the mix shall be based on the void content of the coarse aggregate.

2.18 GRANULAR BASE

- A. Use structural backfill material as specified in Section 02220 Excavation, Backfilling, and Compaction.

2.19 TRIAL BATCH AND LABORATORY TESTS

- A. Before placing any concrete, a testing laboratory designated by the Contractor shall prepare a trial batch of Class A concrete, based on the preliminary concrete mixes submitted. Concrete shall conform to the requirements of this section. Prepare the trial batch using the aggregates, cement, and admixture proposed for the project. The cost of laboratory trial batch tests will be borne by the Contractor. Perform trial batch testing at no additional cost to the Owner.

2.20 SHRINKAGE LIMITATION

- A. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.036% or 0.042%, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to Class A concrete.
- B. If the trial batch specimens do not meet the shrinkage requirements, revise the mix design and/or materials and retest.

2.21 WORKABILITY

- A. Concrete shall be of such consistency and composition that it can be worked readily into the forms and around the reinforcement without excessive vibrating and without permitting the materials to segregate or free water to collect on the surface.
- B. The proportions shall be adjusted to secure a plastic, cohesive mixture, and one that is within the specified slump range.
- C. To avoid unnecessary changes in consistency, obtain the aggregate from a source with uniform quality, moisture content, and grading. Handle materials to minimize variations in moisture content that would interfere with production of concrete of the established degree of uniformity and slump.

PART 3 - EXECUTION

3.01 SITE-MIXED CONCRETE

- A. Conform to ACI 304 as modified by these specifications.
- B. Use a batch-type mixer capable of combining the aggregates, cement, and water within the specified time into a thoroughly mixed and uniform mass and capable of discharging the mixture without segregation.
- C. Use equipment that can accurately proportion cement, coarse and fine aggregates, admixtures, and water. Proportion cement and aggregate by weight.
- D. Discharge each entire batch before recharging. Do not allow any batch to exceed the manufacturer's rated capacity of the mixer.
- E. Mixing time shall be as follows:
 - 1. For mixer of a capacity of 1 cubic yard or less, one and one-half minutes after batching is completed.

2. For mixers of capacities larger than 1 cubic yard, one and one-half minutes plus one-half minute for each additional 1/2-cubic-yard capacity or fraction thereof in excess of 1 cubic yard.
3. The mixer shall revolve at a uniform rate as specified by the manufacturer for the mixing equipment.

3.02 READY-MIXED CONCRETE

- A. Provide ready-mixed concrete conforming to ASTM C94 as modified by these specifications.
- B. Convey concrete from the truck to the place of final deposit as rapidly as practicable by methods that will prevent segregation or loss of ingredients to maintain the quality of the concrete. Place no concrete more than 90 minutes after mixing has begun for that particular batch. If it is necessary to add water to obtain the specified slump, add water per ASTM C94, but do not exceed the water content of the reviewed design mix.
- C. Use dry-batched concrete or jobsite mix only when haul time is excessive. Do not retemper partially hardened concrete.
- D. Keep a record showing time and place of each pour of concrete, together with transit-mix delivery slips certifying the contents of the pour.

3.03 PRIOR TO PLACING CONCRETE

- A. Subgrade: Compact the subgrade and/or bedding. Saturate the subgrade approximately eight hours before placement and sprinkle ahead of the placement of concrete in areas where vapor barrier is not used. Remove all standing water, mud, and foreign matter before concrete is deposited.
- B. Contractor has the option to provide mud slabs to obtain a dry and stable working platform for placement of slabs.
- C. Granular Base: When indicated in the drawings, install a granular base beneath the slab on grade or a structural foundation. Place the granular material on a compacted subgrade and compact the granular base to the same density as the subgrade.

3.04 PLACING CONCRETE

- A. Placement shall conform to ACI 304 as modified by these specifications.
- B. Coordinate in advance of concrete placement the sequence of placement to assure that construction joints will occur only as designed. Provide Owner's Representative with a copy of the sequence of placement in advance of placement.
- C. Alternate sections of concrete walls and slabs may be cast simultaneously. Do not place adjacent sections of walls and slabs until seven days after placement of first placed concrete.

- D. Notify the Owner's Representative of readiness, not just intention, to place concrete in any portion of the work. This notification shall be such time in advance of the operation as the Owner's Representative deems necessary to allow observation of the work at the location of the proposed concrete placing. Failure of sufficient advance notification will be cause for delay in placing until observations can be completed. Forms, steel, screeds, anchors, ties, inserts, and other embedded items shall be in place before the Contractor's notification of readiness is given.
- E. Schedule sufficient equipment for continuous concrete placing. Provide for backup equipment and procedures to be taken in case of an interruption in placing. Provide backup concrete vibrators at the project site. Test concrete vibrators the day before placing concrete.
- F. Do not place concrete until all free water has been removed or has been diverted by pipes or other means and carried out of the forms, clear of the work. Do not deposit concrete underwater, and do not allow free water to rise on any concrete until the concrete has attained its initial set. Do not permit free or storm water to flow over surfaces of concrete so as to injure the quality or surface finish.
- G. Where a vapor barrier is installed, do not puncture the vapor barrier by stakes or any other concrete accessory. Repair any holes in the vapor barrier by patching before placing concrete.
- H. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing. Do not deposit concrete in large quantities in one place to be worked along the forms with a vibrator.
- I. Use mechanical vibration in placing concrete to eliminate rock pockets and voids, to consolidate each layer with that previously placed, to completely embed reinforcing bars and fixtures, and to bring just enough fine material to exposed surfaces to produce a smooth, dense, and even texture. Vibrators shall be of the high-frequency internal type, and the number in use shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. In all cases, at least two vibrators shall be available at the site. Use external vibrators for consolidating concrete when the concrete is otherwise inaccessible for adequate consolidating. Construct forms with sufficient strength to resist displacement or damage when external vibrators are used.
- J. Do not place concrete during rainstorms. Protect concrete placed immediately before rainstorms to prevent rainwater from coming in contact with freshly placed or uncured concrete. Keep sufficient protective covering ready at all times for this purpose.
- K. Elephant Trunks: Use hoppers and elephant trunks or drop chutes to prevent the free fall of concrete that results in separation of coarse particles.
- L. Chutes: Use metal or metal-lined chutes with a slope not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20 feet long and chutes not meeting the slope requirement may be used only if they discharge into a hopper before distribution.

- M. Deposit concrete continuously and in level layers of such thickness (not exceeding 2 feet in depth) so that no concrete will be deposited on concrete that has hardened sufficiently to cause the formation of seams, planes of weakness, or cold joints.

3.05 TIME BETWEEN POURS

- A. At least two hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Place beams, girders, brackets, column capitals, and haunches monolithically as part of the floor or roof system, unless otherwise indicated in the drawings.

3.06 MAXIMUM HEIGHT OF CONCRETE POURS AND FREE FALL

- A. Do not drop concrete freely into place from a height greater than 6 feet in unexposed work and 4 feet in exposed work. Use tremies or pumps where the drop exceeds these limits. See Section 03111: Concrete Form Work also.

3.07 PUMPING CONCRETE

- A. Conform to the recommendations of ACI 304.2R except as modified herein.
- B. Base pump size on rate of concrete placement, length of delivery pipe or hose, aggregate size, mix proportions, vertical lift, and slump of concrete.
- C. Minimum inside diameter of pipe or hose shall be based on the maximum aggregate size as follows:
 - 1. 3/4-inch-maximum aggregate: 2 inches minimum inside diameter.
 - 2. 1-1/2-inch-maximum aggregate: 4 inches minimum inside diameter.
- D. Do not use aluminum pipes for delivery of concrete to the forms.
- E. Before pumping is started, prime the delivery pipe or hose by pumping mortar through the line using 5 gallons of mortar for each 50 feet of delivery line. Do not deposit mortar in the forms.

3.08 HOT WEATHER REQUIREMENTS

- A. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation in accordance with ACI 301, ASTM C94, and the following.
- B. When the weather is such that the temperature of the concrete as placed would exceed 90°F, use ice or other means of cooling the concrete during mixing and transportation so that the temperature of the concrete as placed will not exceed 95°F.
- C. Take precautions when placing concrete during hot, dry weather to eliminate early setting of concrete. This includes protection of reinforcing from direct sunlight to

prevent heating of reinforcing, placing concrete during cooler hours of the day, and the proper and timely application of specified curing methods.

- D. There will be no additional reimbursement to the Contractor for costs incurred for placing concrete in hot weather.

3.09 COLD WEATHER REQUIREMENTS

- A. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306 and the following.
- B. When the temperature of the surrounding atmosphere is 40°F or is likely to fall below this temperature, use heated mixing water not to exceed 140°F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.
- C. When placed in the forms during cold weather, maintain concrete temperature at not less than 55°F. All materials shall be free from ice, snow, and frozen lumps before entering the mixer.
- D. Maintain the air and the forms in contact with the concrete at temperatures above 40°F for the first five days after placing, and above 35°F for the remainder of the curing period. Provide thermometers to indicate the ambient temperature and the temperature 2 inches inside the concrete surface.
- E. There will be no additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

3.10 BONDING TO OLD CONCRETE

- A. Coat the contact surfaces with epoxy bonding compound. The method of preparation and application of the bonding compound shall conform to the manufacturer's printed instructions and recommendations for specific application for this project.

3.11 GROUTING MACHINERY FOUNDATIONS

- A. Block out the original concrete or finish off a sufficient distance below the bottom of the machinery base to provide for the thickness of grout shown on the drawings. After the machinery has been set in position and placed at the proper elevation by steel wedges, the space between the bottom of the machinery base and the original pour of concrete shall be filled with a pourable nonshrink grout. Grout and grouting procedure shall be in accordance with API 686, Chapter 4, paragraphs 3.6 and 3.7, and Chapter 5.

3.12 BACKFILL AGAINST WALLS

- A. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.

- B. Do not backfill the walls of structures that will be laterally restrained or supported by suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.

3.13 CONCRETE TESTS

- A. Concrete quality testing will be performed on the concrete by the Contractor per Section 01410, Testing and Testing Laboratory Services and as follows:
 - 1. Frequency of Sampling: Cast four concrete test cylinders from each 50 cubic yards, or fraction thereof, of each class of concrete placed in any one day. Sampling and curing of cylinders shall conform to ASTM C31.
 - 2. Strength Testing: Test cylinders in accordance with ASTM C39. Test one cylinder at 7 days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28 days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use the fourth cylinder for the test result.
 - 3. Determine concrete slump by ASTM C143 with each strength test sampling and as required to establish consistency.
 - 4. Determine air content of the concrete using ASTM C231 to verify the percentage of air in the concrete immediately prior to depositing in forms.
 - 5. Concrete acceptance shall be based on the requirements of ACI 318.
- B. To facilitate concrete sampling and testing, the Contractor shall:
 - 1. Furnish labor to assist the Owner in obtaining and handling samples at the project site.
 - 2. Advise the Owner in advance of concrete placing operations to allow for scheduling and completion of quality testing.
 - 3. Provide and maintain facilities for safe storage and proper curing of concrete test specimens on the project site, as required by ASTM C31.

END OF SECTION

SECTION 033500

CONCRETE FINISHING AND CURING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section describes materials and methods of concrete finishes, curing, repair of defects, and surface protection.

1.02 SUBMITTALS

- A. Submit shop drawings in accordance with the General Conditions and Section 01340 Shop Drawings, Working Drawings and Samples.
- B. Submit curing compound manufacturer's statement of compliance with these specifications and recommended coverage to meet or exceed the specified tests. Submit manufacturer's application instructions.

PART 2 - MATERIALS

2.01 EPOXY BONDING COMPOUND

See Section 03300.

2.02 CURING COMPOUND

- A. Curing compound shall conform to ASTM C309, Type 1-D, Class A.
- B. Curing compound shall be compatible with required finishes and coatings.

2.03 MORTAR FOR REPAIR OF CONCRETE

- A. Mortar used for repair of concrete shall be made of the same materials as used for concrete, except that the coarse aggregate shall be omitted, and the mortar shall consist of not more than one-part cement to two and one-half parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for handling and placing.

2.04 CLEAR FLOOR HARDENER (SURFACE APPLIED)

- A. Floor hardener shall be a colorless, aqueous solution of zinc and/or magnesium fluosilicate. Each gallon of the fluosilicate solution shall contain not less than 2 pounds of crystals. Hardener shall be Mastertop CST, a product of Master Builders Company, Cleveland, Ohio; Burke-O-Lith, a product of Edoco Burke Company; or equal. The

solution shall be delivered ready for use in the manufacturer's original sealed containers.

2.05 BURLAP MATS

- A. Conform to AASHTO M182.

2.06 SISAL-KRAFT PAPER AND POLYETHYLENE SHEETS FOR CURING

- A. Conform to ASTM C171.

2.07 DUSTPROOF/SEALER (DPS):

- A. Manufacturers:
 - 1. Armorseal Rexthane 1 manufactured by Sherwin Williams.
 - 2. Duraguard 300HS manufactured by ChemMasters.
 - 3. Eucothane manufactured by the Euclid Chemical Company.
 - 4. Or acceptable equivalent product.
- B. Provide a high solid, single component, moisture cure urethane with VOC compliance.
- C. Provide surface primer in accordance with manufacturer's printed instructions.
- D. Colors to be selected by Engineer.

PART 3 - EXECUTION

3.01 CONCRETE FINISHES

- A. Finish concrete surfaces in accordance with the following schedule:

Finish Designation	Area Applied
F-1	Beams, columns, and exterior walls not exposed to water or view.
F-2	Exterior and interior walls, beams, and columns exposed to water, unless such items are to be coated.
F-3	Walls, beams, and columns of structures or buildings exposed to view and to 1 foot below water level or finished grade. Underside of formed floors or slabs. EXCEPTION: surfaces that are to be coated.
F-4	Exterior and interior surfaces to be coated.
S-1	Slabs and floors to be covered with concrete or grout.
S-2	Slabs and floors not water bearing.
S-3	Slab surfaces on which mechanical equipment moves. Slab surfaces to receive hardener.
S-4	Slabs and floors of structures or buildings exposed to view, which are water bearing, or to receive crystalline waterproofing.
S-5	Slabs and floors at slopes greater than 10% and stairs.
E-1	Exposed edges. EXCEPTION: edges normally covered with earth.
E-2	Top of walls, beams, and similar unformed surfaces.

- B. Finish F-1: Repair defective concrete, fill depressions deeper than 1/2 inch, and fill tie holes.
- C. Finish F-2: Repair defective concrete, remove fins, fill depressions 1/4 inch or deeper, and fill tie holes.
- D. Finish F-3: In addition to Finish F-2, fill depressions and airholes with mortar. Dampen surfaces and then spread a slurry consisting of one-part cement and one and one-half parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.
- E. Finish F-4: Repair defective concrete, remove fins, fill depressions 1/16 inch or deeper, fill tie holes, remove mortar spatter, and remove bulges higher than 1/16 inch.
- F. Finish S-1: Screed to grade without special finish.
- G. Finish S-2: Smooth steel trowel finish.
- H. Finish S-3: Steel trowel finish free from trowel marks and all irregularities.
- I. Finish S-4: Steel trowel finish without local depressions or high points and apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.
- J. Finish S-5: Steel trowel finish without local depressions or high points. Apply a stiff bristle broom finish. Leave broom lines parallel to the direction of slope drainage.

- K. Finish E-1: Provide chamfer or beveled edges per Section 03111: Concrete Formwork.
- L. Finish E-2: Strike smooth and float to an F-3 or F-4 finish.

3.02 FINISHING OF FORMED SURFACES

- A. Water cure surfaces until finishing and repairing are completed.
- B. Perform finish work as soon as possible after forms are removed. Remove fins and irregularities by grinding or rubbing, fill depressions deeper than specified with mortar, and fill tie holes.
- C. Ream tie holes with toothed reamers until surface of hole is rough and clean. Coat surface with epoxy bonding compound and fill with mortar.
- D. Finish tapered tie holes as follows:
 - 1. Sandblast tie rod hole and blow clean prior to filling.
 - 2. Drive rubber plug, with one end open, to the center of the hole. Plug size shall be larger in diameter than the diameter of the hole at the center of the wall.
 - 3. Coat entire annular surface of the hole with epoxy prior to filling with mortar. Apply epoxy in accordance with manufacturer's instructions.
 - 4. Fill each side of hole with mortar. Apply mortar to the "wet" side of the wall first. Consolidate mortar solidly into the hole.
 - 5. Notify Owner's Representative of tie rod filling schedule.

3.03 REPAIR OF DEFECTS

- A. Do not repair defects until concrete has been reviewed by the Owner's Representative.
- B. Surface Defects:
 - 1. Repair surface defects that are smaller than 1 foot across in any direction and are less than 1/2 inch in depth.
 - 2. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface and at least 3/8 inch deep, thoroughly dampen the surface, work into the surface a bonding grout (one part cement to one part fine sand), fill the hole with mortar, match the finish on the adjacent concrete, and cure as specified.
- C. Severe Defects:
 - 1. Repair severe defects that are larger than surface defects but do not appear to affect the structural integrity of the structure.

2. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges of the hole perpendicular to the surface, sandblast the surface, coat the sandblasted surface with epoxy bonding compound, place nonshrink grout as specified in Section 03300: Concrete, match the finish on the adjacent concrete, and cure as specified.

D. Major Defects

1. If the defects are serious or affect the structural integrity of the structure or if patching does not satisfactorily restore the quality and appearance to the surface, the Owner's Representative may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section.

3.04 REPAIR OF CRACKS IN CONCRETE

- A. Repair concrete cracks in liquid containment structures that are greater than 0.01 inch and less than 0.1 inch in width by epoxy pressure injection. Epoxy pressure injection shall be Sikadur 52, or equal.
1. Preparation: Insert and anchor a one-way polyethylene valve or pipe nipple in holes drilled into crack. Position them every 6 inches or 18 inches on center depending on the width of the crack. The injecting operation for vertical cracks shall consist of pumping the epoxy grout into the lowest position first and working vertically up in the cracks. Maintain a slow, steady pressure rather than a rapid buildup of pressure. When grouting material reaches the next tube, stop off the present position and follow the same procedure on the next position.
 2. Upon completion of the epoxy grouting, remove the epoxy gel used to hold the valve or nipple by applying a direct flame to the epoxy and scraping it off. Fill the holes with the same material as used for patching the surface.
 3. While the valves or nipples are installed first, the grouting operation shall not commence until after the patchwork has been completed and has sufficiently cured.
- B. Repair cracks in concrete structures that are wider than 1/10 inch by cutting out a square edged and uniformly aligned joint 3/8 inch wide by 3/4 inch deep, preparing exposed surfaces of the joint, priming the joint, and applying polyurethane joint sealant in accordance with Section 03151.
- C. If the cracks are serious or affect the structural integrity or function of the element, the Owner's Representative may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section. Where concrete is removed or has spalled, wire brush the exposed rebar, if any, and apply Sika Armatec 110 or equal, before repairing the concrete.
- D. After leakage testing dewater the structure, repair leaking concrete cracks from inside the structure, and retest the structure.

3.05 CURING AND PROTECTION

- A. Water cure cast-in-place concrete for liquid containment walls, slabs, channels, and footings by Method 1, 2, or 3 for a period of five days (minimum) prior to applying other curing methods. Do not submerge concrete placed in the dry until it has attained sufficient strength to adequately sustain the stress involved and do not subject it to flowing water across its surface until it has cured four days. Start curing of concrete as soon as possible without damaging surface and not later than two hours after placing.
- B. Cure concrete surfaces in accordance with the methods specified herein for the different parts of the work and described in the following paragraphs. These methods are considered to be minimum for curing. The conditions that exist in the field during placement and curing may require additional curing procedures and efforts to ensure proper protection and curing of the concrete. Select and implement the appropriate method commensurate with climatic conditions.

Curing Method	Area Permitted
1	All surfaces.
2	All surfaces.
3	Slabs and floors.
4	All surfaces of non-hydraulic structures when maximum ambient temperature will not exceed 80°F and humidity will not drop below 40% on the day of concrete placement and for the three days following.

- C. Where wooden forms are used, wet forms immediately before concreting and keep moist by sprinkling until removed. Keep exposed surfaces of formed concrete moist until commencement of curing.
- D. Use proper concrete placing and curing methods at all times to limit the amount of crazing and cracking of the structures during initial setting and shrinking of the concrete. Repair cracks and coat with a cementitious crystalline waterproofing system.
- E. Cure concrete for not less than 14 days after placing in accordance with one of the following methods.
1. Method 1, Water Spray Method:

Tightly close off concrete surfaces to be cured by bulkheads or other means or entirely surround by tight enclosures, and keep the concrete surfaces moist by sprinkling, spraying, or other means.
 2. Method 2, Wet-Burlap-Mat Method:
 - a. Thoroughly wet and cover concrete surfaces to be cured with wet burlap mats as soon as the forms have been stripped or as soon as the concrete has set sufficiently to avoid marring the surface. Keep entire

concrete surface and burlap continuously and completely wet during the entire curing period.

3. Method 3, Curing Blanket Method:

- a. Thoroughly wet concrete surfaces to be cured and cover with curing blankets as soon as the concrete has set sufficiently to avoid marring the surface. The curing blankets shall be weighted to maintain close contact with the concrete surface during entire curing period. Should the curing blankets become torn or otherwise ineffective, keep surfaces moist and replace damaged sections. The curing blankets shall consist of one of the following two types:
 - a. Sheets of heavy waterproof sisal-kraft paper laid with the edges butted together and with the joints between strips sealed with 2-inch-wide strips of sealing tape or with the edges lapped not less than 3 inches and fastened together with waterproof cement to form continuous watertight joints; or
 - b. Sheets of clean polyethylene, having a minimum thickness of 4 mils, layed with edges butted together, and with the joints between sheets sealed with 1-inch-wide strips of acetate tape.

During the curing period, do not permit traffic of any nature or depositing of objects, temporary or otherwise, on the curing blankets.

4. Method 4, Curing Compound Method:

- a. Spray the surface with two coats of liquid curing compound. Apply in accordance with the manufacturer's instructions to cover the surface with a uniform film that will seal thoroughly. Apply second coat at 90 degrees for the first coat.
- b. Apply curing compound immediately after completion of the finish on unformed surfaces and within two hours after removal of forms on formed surfaces. Repair formed surfaces within the said two-hour period; provided, however, that any such repairs which cannot be made within the said two-hour period shall be delayed until after Method 1, 2, or 3 has been applied. When repairs are to be made to an area on which curing compound has been applied, first sandblast the area to remove the compound, then repair.
- c. Wherever curing compound may have been applied to surfaces against which concrete subsequently is to be placed and to which it is to adhere, remove the curing compound entirely by sandblasting prior to the placing of new concrete.
- d. Where the curing compound method is used, exercise care to avoid damage to the seal during the curing period. Should the seal be

damaged or broken before the expiration of the curing period, repair the damaged portions immediately by the application additional curing compound.

5. It is the responsibility of the Contractor to select the appropriate curing method in response to climatical and/or site conditions occurring at the time of concrete placement. Take appropriate measures as described in ACI 305 and 306 for protecting and curing concrete during hot and cold weather.

3.06 CLEAR HARDENER APPLICATION (SURFACE APPLIED)

- A. Cure, clean, and keep floors dry to receive hardener. Complete work immediately above floors prior to applying hardener. Apply hardener evenly, using three coats, allowing 24 hours between coats. The first coat shall be one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat so as to remain wet on the concrete surface for 15 minutes. Apply proprietary hardeners in conformance with the manufacturer's instructions. After the final coat is completed and dry, remove surplus hardener from the surface by scrubbing and mopping with water.
- B. Apply hardener to the surfaces designated in the drawings.

3.07 DUSTPROOF/SEALER (DPS):

- A. Apply primer in accordance with manufacturer's printed instructions.
- B. Give particular attention to priming of concrete substrate and time laps between coats when more than one conditioning coat is required.
- C. Mix colored polyurethane dustproof/sealer surface treatment and apply to sound, fully cured, dry and thoroughly clean concrete slabs in strict accordance with manufacturer's printed instructions.
 1. Total dry film thickness for both primer and topcoat shall be 4 mils.

END OF SECTION

SECTION 042000

UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS AND REQUIREMENTS

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

1.02 SUMMARY

- A. Section includes the following:
 - 1. Concrete unit masonry.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following installed compressive strengths (f'm):
 - 1. For concrete unit masonry:
 - a. f'm = 2,000 pounds per square inch.
 - b. As indicated on structural Drawings.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Division 1 General Requirements, Shop Drawings covering the items included under this Section. Submittals shall be issued in an electronic format. Comments will be returned in an electronic format.
- B. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.
 - 1. Block data required consists of the following:
 - a. Block grade.
 - b. Block type.
 - c. Weight classification.
 - d. Material test data:
 - 1) Minimum compressive strength.
 - 2) Maximum water absorption (percent).
 - 3) Moisture content percent total absorption.

- 4) Linear shrinkage percent.
 - e. Material Certificate of Compliance
 - f. Proof of compliance of 30-day curing period.
 - 1) Date of manufacture.
 - 2) Date of shipping.
- 2. Mortar data required consists of the following:
 - a. Mortar.
 - b. Method of manufacture (proportion or property).
 - c. Material test data:
 - 1) Aggregate for mortar (ASTM C 144 with no exceptions to gradation limits).
 - 2) Mortar composition and properties (ASTM C 780) Proportion Method.
 - 3) Mortar properties (ASTM C 270) Property Method.
 - d. Material Certificate of Compliance.
- 3. Grout data required consists of the following:
 - a. Grout Mixes: Include description of type and proportion of grout ingredients.
 - b. Material test data: Compressive strength (ASTM C 1019).
 - c. Material Certificate of Compliance.
- 4. Joint reinforcement, ties, anchors, and flashing:
 - a. Manufacturer's literature.
 - b. Material Certificate of Compliance.
- C. Shop Drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315, Details and Detailing of Concrete Reinforcing, showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement. Include special reinforcement required for openings through masonry structures.
- D. Samples for initial selection purposes of the following:
 - 1. Unit masonry samples in small-scale form showing full extent of colors and textures available for each different exposed masonry unit required.
 - a. Submit a minimum of 18 standard or custom colors for CMU color selection.

2. Colored masonry mortar samples showing full extent of colors available.
- E. Samples for verification purposes of the following:
1. Full-size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction.
 2. Colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.
- F. Quality Assurance Submittals:
1. Material certificates shall be signed by manufacturer and CONTRACTOR, certifying that each material complies with requirements.
 2. Material test reports shall be from a qualified independent testing laboratory employed and paid by CONTRACTOR indicating and interpreting test results relative to compliance of the masonry materials with requirements:
 3. Cold weather construction procedures evidencing compliance with requirements specified in "Project Conditions" paragraph of this Section.
 4. Hot weather construction procedures evidencing compliance with requirements specified in "Project Conditions" paragraph of this Section.
 5. Qualification data for Contractors, firms, and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include list of completed projects with project name, address, telephone number, names of Engineers and Owners, and other information specified.
 6. Results from tests and inspections performed by OWNER's Representatives shall be reported promptly and in writing to ENGINEER and CONTRACTOR.

1.05 QUALITY ASSURANCE

- A. Mason Qualifications: The masonry foreman responsible for placement of reinforced masonry is required to hold certification for MIM training program for reinforced unit masonry assemblies.
- B. Unit Masonry Standard: Comply with TMS 402/ ACI 530.1/ASCE 6, Specifications for Masonry Structures, except as otherwise indicated.
- C. A qualified Professional Engineer must inspect foundations for compliance with dimensional tolerances specified in referenced unit masonry standard, prior to masonry wall construction.

1. Engineer Qualifications: Professional Engineer legally authorized to practice surveying in jurisdiction where Project is located.
- D. Masonry Contractor Qualifications: The masonry Contractor shall submit in writing 5 projects of similar size and construction type to exhibit the experience level necessary to perform the Work. List project location, size, wall construction type, Owner contact, and telephone number.
- E. Masonry Inspection:
1. A qualified Engineer or Architect must inspect masonry during construction for compliance with the Contract Documents, including conducting the pre-installation conference, inspection of the field-constructed mock-ups, and periodic wall inspection of the critical portions of masonry construction, including flashing, weep hole construction, and proper unit bedding and joint installation techniques for structural integrity and weather-tightness.
 2. Prism Tests: For each type of wall construction indicated, masonry prisms shall be tested per ASTM C 1314.
 3. Grout compressive strength will be tested per ASTM C 1019 for property specification and C 476 for proportion specification.
- F. Single Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.
- G. Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.
- H. Field-Constructed Mock-Ups: Prior to installation of unit masonry, erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups to comply with the following requirements using materials indicated for final unit of Work:
1. Locate mock-ups on Site in locations indicated, or if not indicated, as directed by ENGINEER.
 - a. Build mock-ups for the following types of masonry in sizes of approximately 8 feet long by 4 feet high by full thickness, including face and backup wythes as well as accessories.
 - b. Each type of exposed unit masonry construction.
 2. Notify ENGINEER 1 week in advance of the dates and times when mock-ups will be erected. Do not proceed with masonry work until mock-up is inspected and

accepted. If mock-up is not acceptable, remove mock-up and construct additional mock-ups incorporating corrections until acceptable.

3. Protect mock-ups from the elements with weather-resistant membrane.
4. Retain and maintain mock-ups during construction in undisturbed condition as standard for judging completed unit masonry construction.
 - a. When directed, demolish and remove mock-ups from Site.

- I. Pre-installation Conference: Conduct conference at Site to comply with requirements of Division 1 General Requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver masonry materials to Site in undamaged condition.
- B. Store and handle masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.
- C. Store cementitious materials off the ground, under cover, and in dry location.
- D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.05 PROJECT CONDITIONS

- A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each workday. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours, and concentrated loads for at least 3 days after building masonry walls or columns.

- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that come in contact with such masonry.
1. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and doorframes, as well as similar products with painted and integral finishes from mortar droppings.
- D. Cold Weather Construction:
1. Perform the following construction procedures while Work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation, except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 10 degrees F (6 degrees C).
 2. 40 degrees F (4 degrees C) to 32 degrees F (0 degrees C):
 - a. Mortar: Heat mixing water to produce mortar temperature between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).
 - b. Grout: Follow normal masonry procedures.
 3. 32 degrees F (0 degree C) to 25 degrees F (-4 degrees C):
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 4. 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.

- c. Heat both sides of walls under construction using salamanders or other heat sources.
 - d. Use windbreaks or enclosures when wind is in excess of 15 miles per hour.
- 5. 20 degrees F (-7 degrees C) and below:
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 - c. Masonry Units: Heat masonry units so that they are above 20 degrees F (-7 degrees C) at the time of laying.
 - d. Provide enclosure and auxiliary heat to maintain an air temperature of at least 40 degrees F (4 degrees C) for 24 hours after laying units.
- 6. Do not heat water for mortar and grout to above 160 degrees F (71 degrees C).
- 7. Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry temperature ranges apply to anticipated minimum night temperatures.
- 8. 40 degrees F (4 degrees C) to 32 degrees F (0 degree C):
 - a. Protect masonry from rain or snow for at least 24 hours by covering with weather-resistant membrane.
- 9. 32 degrees F (0 degree C) to 25 degrees F (-4 degrees C):
 - a. Completely cover masonry with weather-resistant membrane for at least 24 hours.
- 10. 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):
 - a. Completely cover masonry with weather-resistant insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
- 11. 20 degrees F (-7 degrees C) and below:
 - a. Except as otherwise indicated, maintain masonry temperature above 32 degrees F (0 degree C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps, or other methods proven

to be satisfactory. For grouted masonry, maintain heated enclosure to 40 degrees F (4 degrees C) for 48 hours.

- 12. Do not lay masonry units that are wet or frozen.
- 13. Remove masonry damaged by freezing conditions.
- E. Hot Weather Construction: When the ambient air temperature exceeds 100 degrees F or 90 degrees F with a wind velocity greater than 8 miles per hour, do not spread mortar beds more than 4 feet ahead of masonry. Set masonry units within 1 minute of spreading mortar.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Integral Water-Repellent Admixture:
 - a. Dry Block Water-Repellent Block Admixture by W.R. Grace and Co.
 - b. Rheomix Rheopel by Master Builders, Inc.
 - 2. Integral Water-Repellent Mortar Admixture:
 - a. Dry-Block Mortar Admixture by W.R. Grace and Co.
 - 3. Joint Reinforcement:
 - a. Dur-O-Wal, Inc.
 - b. Heckman Building Products, Inc.
 - c. Hohmann and Barnard, Inc.
 - d. Masonry Reinforcing Corp. of America.
 - 4. Ties and Anchors:
 - a. Dur-O-Wal, Inc.
 - b. Heckman Building Products, Inc.
 - c. Hohmann and Barnard, Inc.
 - d. Masonry Reinforcing Corp. of America.
 - 5. Metal Flashing:
 - a. "Cheney Flashing (Dovetail)," Cheney Flashing Company, Inc.
 - b. "Cheney Flashing (Sawtooth)," Cheney Flashing Company, Inc.
 - c. "Keystone Three-Way Interlocking Thruwall Flashing," Keystone Flashing Co.

6. Copper Fabric Laminate Flashing:
 - a. "Copper Fabric," Afco Products, Inc.
 - b. "Type FCC-Fabric Covered Copper," Phoenix Building Products.
 - c. "Copper Fabric Flashing," Sandell Manufacturing Co., Inc.
 - d. "York Copper Fabric Flashing," York Manufacturing, Inc.
7. Single-wythe Flashing Unit System:
 - a. "Blok-Flash," Sandell Manufacturing Company, Inc.
8. Mortar Net:
 - a. Hohmann and Barnard, Inc.
9. Plastic Rectangular Weep Hole:
 - a. No. 342 Plastic Weep Hole, Hohmann and Barnard.
 - b. Wire-Bond No. 3603 Clear Rectangular Vent, Masonry Reinforcing Corp. of America.
10. Extruded Polystyrene Board Insulation:
 - a. "Styrofoam Scoreboard," Dow Chemical USA.
 - b. "Foamular 250," Owens Corning.
 - c. "CertiFoam 25 SE," DiversiFoam Products
 - d. "Green Guard SB," Pactiv Corporation.
11. Loose Granular Vermiculite Insulation:
 - a. "Zonolite Masonry Insulation," Grace Construction Products.
12. Foamed-in-Place Masonry Wall Insulation. Two-part amino-plast system, plastic resin and catalyst foaming agent surfactant with enhanced fire-safety performance:
 - a. Core-Fill 500.
 - b. Polymaster R501.

2.02 MATERIALS

- A. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.

2.03 CONCRETE MASONRY UNITS

- A. Comply with requirements indicated below applicable to each form of concrete masonry unit required.
1. Provide 2-core, plain-end units for walls vertically reinforced.
 2. Provide special shapes where indicated and as follows:
 - a. For lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
 - b. Bullnose units for outside corners of interior work only unless otherwise indicated.
 3. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength for exposed units.
 4. Concrete Block: Provide units complying with characteristics indicated below for grade, face size, exposed face and, under each form included, for weight classification.
 5. Normal-weight Units: Normal-weight units shall be used for exterior walls below grade and exterior units of single- and multi-wythe walls above grade. Units shall be Grade N, manufactured from normal weight aggregates conforming to ASTM C 90.
 6. Lightweight Units: Lightweight units shall be used for interior walls and interior wythe of exterior walls above grade. Units shall be Grade S, manufactured from lightweight expanded or sintered blast furnace slag, clay, shale, or slate conforming to ASTM C 90.
 7. Size: Provide concrete masonry units complying with requirements indicated below for size, that are manufactured to specified face dimensions within tolerances specified in the applicable referenced ASTM specification for concrete masonry units.
 - a. Concrete Masonry Units: Manufactured to specified dimensions of 3/8 inch less than nominal widths by nominal heights by nominal lengths indicated on Drawings.
 8. Provide Cured Units: Manufacturer must store units outside after manufacture a minimum of 30 days under a covered storage area to protect the units from additional moisture during the curing (drying) process.
 9. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

10. Where special finishes are indicated, provide units with exposed faces of the following general description:
 - a. Standard aggregate, split face finish.
 - b. Standard aggregate, ground face finish.
 - c. Standard aggregate, integral color admixture as selected from full line of manufacturer's standard available colors.
 11. Where special patterns are indicated, provide units with exposed faces matching color, texture, and pattern. Integral Water Repellent Admixture: An integral liquid polymer admixture mixed with concrete during production of the CMU which cross-links and becomes permanently locked into the CMU, bond beam, or CMU lintel to provide resistance to water penetration to achieve a Class E rating when tested in accordance with ASTM E 514-74.
- B. Hollow Load-Bearing Concrete Masonry Units: ASTM C 90, Grade N, and as follows:
1. Unit Compressive Strength: Provide units with minimum average net area compressive strength indicated below:
 - a. 2,000 pounds per square inch.
 2. Weight Classification:
 - a. Normal weight (greater than 125 pounds per cubic foot concrete).

2.04 MORTAR AND GROUT MATERIALS

- A. Mortar and Grout
1. Compressive Strength: 2,000 pounds per square inch.
- B. Portland Cement: ASTM C 150, Types I or II, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce required mortar color.
- C. Masonry Cement: ASTM C 91:
1. Not allowed
- D. Hydrated Lime: ASTM C 207, Type S.
- E. Aggregate for Mortar: ASTM C 144 with the following exceptions:
1. Delete gradation limit waiver as described in Article 4.4.

2. For joints less than 1/4 inch, use aggregate graded with 100 percent passing the No. 16 sieve.
 3. Colored Mortar Aggregates: Ground marble, granite, or other sound stone, as required to match ENGINEER's sample.
- F. Aggregate for Grout: ASTM C 404.
- G. Integral Water Repellent Admixture for Mortar and Grout: An integral liquid polymer admixture designed specifically for use in a mortar mix, which cross-links and becomes permanently locked into mortar to provide resistance to water penetration to achieve a Class E rating when tested in a wall section in accordance with ASTM E 514-74.
- H. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars.
- I. Water: Clean and potable.

2.05 REINFORCING STEEL

- A. Provide reinforcing steel complying with requirements of referenced unit masonry standard and this Article.
- B. Steel Reinforcing Bars: Material and grade as follows:
1. Billet steel complying with ASTM A 615, Deformed bar.
 2. Grade 60.
- C. Deformed Reinforcing Wire: ASTM A 496.
- D. Plain Welded Wire Fabric: ASTM A 185.

2.06 JOINT REINFORCEMENT

- A. Provide joint reinforcement complying with requirements of referenced unit masonry standard and this Article, formed from the following:
1. Hot-Dip Galvanized Steel Wire: ASTM A 82 for uncoated wire, and with ASTM A 153, Class B-2 (1.5 ounces per square foot of wire surface) for zinc coating applied after pre-fabrication into units.
 - a. Application: Exterior and interior walls.
- B. Description: Welded-wire units pre-fabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with pre-fabricated corner and tee units, and complying with requirements indicated below:

1. Wire Diameter for Side Rods: 0.1483 inch (9 gauge).
2. Wire Diameter for Cross Rods: 0.1483 inch (9 gauge).
3. For single-wythe masonry, provide type as follows with single pair of side rods:
 - a. Ladder design with continuous diagonal cross rods spaced not more than 16 inches on center.
4. For multi-wythe masonry provide type as follows:
 - a. Adjustable (two-piece) type; ladder design with perpendicular cross rods spaced not more than 16 inches on center with one side rod for each face shell of backing wythe with separate ties that extend into facing wythe. Ties have 2 hooks that engage eyes in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have clips to engage a continuous horizontal wire in the facing wythe.
 - 1) Number of Side Rods for Multi-wythe Concrete Masonry: One side rod for each face shell of hollow masonry units more than 4 inches in nominal width, plus one side rod for each wythe of masonry 4 inches or less in nominal width.

2.07 TIES AND ANCHORS

- A. Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standard and of this Paragraph.
 1. Zinc Coated (Galvanized) Steel Sheet: Carbon steel with zinc coating complying with ASTM A 525, Coating Designation G90.
 - a. Application: Use for dovetail slots and where indicated.
 2. Hot-Dip Galvanized Carbon Steel Sheet: ASTM A 366, Class 2, or ASTM A 635; hot-dip galvanized after fabrication to comply with ASTM A 153, Class B.
 - a. Application: Use for anchors.
- B. Steel Plates and Bars: ASTM A 36, hot-dip galvanized to comply with ASTM A 123 or ASTM A 153, Class B3, as applicable to size and form indicated.

2.08 BENT WIRE TIES

- A. Individual units pre-fabricated from bent wire to comply with requirements indicated below:

- B. Type for Masonry where Coursing Between Wythes Align: Unit ties bent from one piece of wire.

2.09 RIGID ANCHORS

- A. Provide straps of form and length indicated, fabricated from metal strips of following width and thickness.

- 1. 1-1/2 inches wide by 1/4-inch thick.

2.10 MISCELLANEOUS ANCHORS

- A. Unit Type Masonry Inserts in Concrete: Cast iron or malleable iron inserts of type and size indicated.

2.11 EMBEDDED FLASHING MATERIALS

- A. Exposed Sheet Metal Flashing: Fabricate from the following metal, complying with requirements specified in Section 076200 and below.

- 1. Stainless Steel: 0.0156 inch (28 gauge) thick.
- 2. Fabricate through-wall metal flashings embedded in masonry as follows:
 - a. With ribs formed in dovetail pattern at 3-inch intervals along length of flashing to provide a 3-way integral mortar bond and weep hole drainage.
- 3. Fabricate metal expansion joint strips from sheet metal indicated above, formed to shape indicated.
- 4. Application: Use where flashing is exposed to exterior and is partly concealed in masonry wall.

2.12 MISCELLANEOUS MASONRY ACCESSORIES

- A. Nonmetallic Expansion Joint Strips: Pre-molded filler strips complying with ASTM D 1056, Type 2 (closed cell), Class A (cellular rubber and rubber-like materials with specific resistance to petroleum base oils), Grade 1 (compression-deflection range of 2-5 pounds per square inch), compressible up to 35 percent, of width and thickness indicated, formulated from the following material:

- 1. Neoprene.

- B. Mortar Net: Provide mortar net made of high-density polyethylene (HDPE) or nylon stands woven into a 90 percent open-mesh, formed into dovetail shape to break up mortar droppings and prevent mortar damming. Mortar net shall be nonreactive with

common building materials, nonabsorbent, shall not support mold or fungus growth, and shall be inedible to insects.

- C. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.13 INSULATION

- A. Extruded Polystyrene Board Insulation: Rigid cellular polystyrene thermal insulation with closed cells and integral high-density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV (25 pounds per square inch compressive strength); in manufacturer's standard lengths and widths; thicknesses as indicated.
 - 1. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.14 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of trisodium phosphate (1/2-cup dry measure) and laundry detergent (1/2-cup dry measure) dissolved in 1 gallon of water.

2.15 MORTAR AND GROUT MIXES

- A. Do not add admixtures, including air-entraining agents, accelerators, retarders, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification for job-mixed mortar and ASTM C 1142 for ready-mixed mortar, of types indicated below.
 - 1. Limit cementitious materials in mortar to Portland cement.
 - 2. For masonry below grade and in contact with earth, and where indicated, use type indicated below:
 - a. Type S.
 - 3. For reinforced masonry use type indicated below unless otherwise indicated on Drawings:
 - a. Type S.

4. For exterior, above-grade load-bearing and non-load-bearing walls and parapet walls, for interior load-bearing walls, for interior non-load-bearing partitions, and for other applications where another type is not indicated, use type indicated below:

- a. Type S.

- D. Colored Aggregate Mortar: Produce mortar of color required by use of colored aggregates in combination with selected cementitious materials.

1. Mix to match ENGINEER's sample.

- E. Grout for Unit Masonry: Comply with ASTM C 476 and referenced unit masonry standard.

2.16 SOURCE QUALITY CONTROL

- A. Concrete Masonry Unit Tests: For each type, class, and grade of concrete masonry unit indicated, units will be tested by qualified independent testing laboratory for strength, absorption, and moisture content per ASTM C 140.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance of unit masonry.
- B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Deliver anchorage items which are to be embedded in other construction before start of such work. Provide setting diagrams, templates, instructions, and directions as required for installation.
- B. Comply with referenced unit masonry standard and other requirements indicated applicable to each type of installation included in Project.
- C. Do Not Wet concrete masonry units.

- D. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units using units of nominal thickness indicated.
- E. When vertical reinforcement is called for, mortar face shell and web of cores containing grout and reinforcing bars.
- F. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 8 inches of masonry between chase or recess and jamb of openings and between adjacent chases and recesses. Masonry directly above chases or recesses wider than 12 inches shall be supported on lintels.
- G. Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.
- H. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.
- I. No masonry shall be supported on wood girders or other form of wood construction.

3.03 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4 inch in 10 feet, or 3/8 inch in a story height not to exceed 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/8 inch in any story or 20 feet maximum, or 1/4 inch in 40 feet or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet, 3/8 inch maximum.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in any bay or 20 feet maximum, or 1/2 inch in 40 feet or more. For top surface of bearing walls do not exceed 1/8 inch between adjacent floor elements in 10 feet or 1/16 inch within width of a single unit.
- C. Variation of Linear Building Line: For position shown in plain and related portion of columns, walls, and partitions, do not exceed 3/8 inch in any bay, or 20 feet maximum, or 3/4 inch in 40 feet or more.
- D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/8 inch or plus 1/8 inch.
- E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 3/8 inch. Do not exceed head joint thickness indicated by more than plus or minus 1/8 inch.

3.04 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.
- B. Lay up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
- D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- E. Stopping and Resuming Work: In each course, rack back 1/2-unit length for 1/2 running bond or 1/3-unit length for 1/3 running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.
- F. Built-In Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
 - 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
 - 2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
 - 3. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.05 MORTAR BEDDING AND JOINTING

- A. Lay solid brick-size masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
- B. Lay hollow concrete masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.

- C. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
- D. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

3.06 STRUCTURAL BONDING OF MULTI-WYTHE MASONRY

- A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes.
- B. Corners: Provide interlocking masonry unit bond in each course at corners unless otherwise shown.
 - 1. Provide continuity with horizontal joint reinforcement at corners using pre-fabricated L-units in addition to masonry bonding.
- C. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
 - 1. Provide individual metal ties.
 - 2. Provide continuity with horizontal joint reinforcement using prefabricated T-units.
- D. Nonbearing Interior Partitions: Build full height of story to underside of solid floor or roof structure above and as follows:
 - 1. Install pressure-relieving joint filler in joint between top of partition and underside of structure above.

3.07 CAVITIES/AIR SPACES

- A. Keep cavities/air spaces clean of mortar droppings and other materials during construction. Strike joints facing cavities/air spaces flush.
- B. Tie exterior wythe to backup with continuous horizontal joint reinforcing.

3.08 MASONRY CELL INSULATION

- A. Two-part core foam system, thermal and acoustical amino-plast masonry foamed-in-place insulation compliant with ASTM D-5116, and meeting UL 723 Surface Burning Characteristics Standards accordingly to ASTM E-84 testing - Class A and Class 1 Flammability Classification
 - 1. Completely fill all cracks, open gaps, and irregular spaces.

2. Foamed-in-place insulation pumped into each cavity through small holes drilled into mortar joints around the entire wall area.
- B. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Polymaster Insulating Foams, R-501 (Basis of Design)
 2. Tailored Chemical Products, Inc., Core-Fill 500.

3.09 HORIZONTAL JOINT REINFORCEMENT

- A. Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcing a minimum of 6 inches.
- B. Space continuous horizontal reinforcement as follows:
1. For multi-wythe walls (solid or cavity) where continuous horizontal reinforcement acts as structural bond or tie between wythes, space reinforcement as required by Code but not more than 16 inches on center vertically.
 2. Reinforce masonry openings greater than 1'-0" wide with horizontal joint reinforcement placed in 2 horizontal joints approximately 8 inches apart immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints.
 3. Cut or interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
 4. Provide continuity at corners and wall intersections by use of prefabricated L- and T-sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 MOVEMENT (CONTROL AND EXPANSION) JOINTS

- A. Install control and expansion joints in unit masonry where indicated. Build in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
- B. Form control joints in concrete masonry as follows:
1. Fit bond breaker strips into hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces.

- C. Build flanges of factory-fabricated expansion joint units into masonry.
- D. Build in horizontal pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting nonmetallic 50 percent compressible joint filler of width required to permit installation of sealant and backer rod specified in Section 079200.
 - 1. Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.11 LINTELS

- A. Install masonry lintel or steel lintels above all masonry openings per Lintel Schedule on Drawings.

3.12 FLASHING/WEEP HOLES

- A. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
- B. Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive/sealant/tape as recommended by flashing manufacturer before covering with mortar.
- C. Install Flashings as follows:
 - 1. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches, and through the inner wythe to within 1/2 inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.
 - 2. At heads and sills, extend flashing as specified above unless otherwise indicated but turn up ends not less than 2 inches to form a pan.
 - 3. Turn down sheet metal flashings at exterior face of masonry to form drip.
 - 4. Cut off concealed flashing flush with face of wall after masonry wall construction is completed.
- D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashings and as follows:
 - 1. Form weep holes by keeping one head joint free and clear of mortar as recommended by MIM.

2. Space weep holes 24 inches on center.
3. In all cavities/air spaces, place mortar net to a minimum height equal to height of first course but not less than 2 inches immediately above flashing embedded in the wall as masonry construction progresses to splatter mortar droppings and to maintain drainage.

3.13 INSTALLATION OF REINFORCED UNIT MASONRY AND BOND BEAMS

- A. Install reinforced unit masonry to comply with requirements of referenced unit masonry standard.
- B. Temporary Formwork: Construct formwork and shores to support reinforced masonry elements during construction.
 1. Construct formwork to conform to shape, line, and dimensions shown. Make sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
- C. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
- D. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- E. Lay CMU units with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross-webs of starting courses in mortar. Maintain head and bed joint widths shown, or if not shown, provide 3/8-inch joints.
- F. Where solid CMU units are shown, lay with full mortar head and bed joints.
- G. Lap all splices in horizontal and vertical reinforcing bars at least 48 bar diameters unless otherwise required by governing Building Code.
- H. Reinforcing bars shall have a minimum clear spacing from inside face of masonry core of a minimum of 1 inch.
- I. Clean reinforcement loose rust, mill scale, earth, ice, or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on Drawings or final Shop Drawings, or bars with reduced cross-section due to excessive rusting or other causes.

- J. Position reinforcing accurately at the spacing indicated. Support secure vertical bars against displacement. Horizontal reinforcing shall be placed as the masonry work progresses. Where vertical bars are shown in close proximity, provide a clear distance between bars of not less than the nominal bar diameter or 1 inch (whichever is greater).
- K. Field Adjustments: If it is necessary to move bars to avoid interference with other reinforcing steel, conduits, or embedded items, and bars are moved more than 1 bar diameter or enough to exceed the specified tolerances, ENGINEER shall be notified and the resulting arrangement of bars shall be subject to acceptance.
- L. Walls:
1. Pattern Bond: Lay CMU wall units in 1/2 running bond with vertical joints in each course centered on units in courses above and below unless otherwise indicated. Bond and interlock each course at corners and intersections. Use special shaped units where shown and as required for corners, jambs, sash, control joints, lintels, bond beams, and other special conditions.
 2. Maintain vertical continuity of core or cell cavities which are to be reinforced and grouted to provide minimum clear dimension indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
 3. Where horizontal reinforced beams (bond beams) are shown, use special units or modify regular units to allow for placement of continuous horizontal reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells of non-reinforced vertical cells, or provide units with solid bottoms.
 4. Grout fill cores of block wall 2 courses below each bond beam supporting roof, floor, and other structural members. Place metal lath under lowest block to be grouted to confine grout pour.
 5. Install two No. 5 vertical bars on each side of all masonry openings extending from 1 inch below lintel bearing point to 2'-0" below the bottom of the window opening unless otherwise indicated on structural Drawings.
- M. Grouting:
1. Use "Fine Grout" per ASTM C 476 for filling spaces less than 4 inches in one or both horizontal directions.
 2. Use "Coarse Grout" per ASTM C 476 for filling 4-inch spaces or larger in both horizontal directions.
 3. Grouting Technique: Use low-lift grouting techniques subject to requirements which follow.

N. Low-Lift Grouting:

1. Provide minimum clear dimension of 2 inches and clear area of 8-square-inch in vertical cores to be grouted.
2. Place vertical reinforcement prior to laying of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters or 10 feet.
3. Lay CMU to maximum pour height. Do not exceed 5-foot height, or if bond beam occurs below 5-foot height, stop pour at course below bond beam.
4. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than 1 hour. Terminate grout pours 1-1/2 inches below top course of pour.
5. Bond Beams: Stop grout in vertical cells 1-1/2 inches below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.

3.14 FIELD QUALITY CONTROL

- A. Testing Frequency: Tests and evaluations listed in this article shall be formed during construction for each 5,000 square feet of wall area or portion thereof.
- B. Prism Test Method: For each type of wall construction indicated, masonry prisms shall be tested per ASTM E 447, Method B, and as follows:
 1. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.
- C. Evaluation of Quality Control Tests: In absence of other indications of noncompliance with requirements, masonry will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

3.15 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.

- C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain ENGINEER's approval of sample cleaning before proceeding with cleaning of masonry.
 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 4. Wet wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
 5. Clean brick by means of bucket and brush hand-cleaning method described in BIA, "Technical Note No. 20 Revised," using the following masonry cleaner:
 - a. Job-mixed detergent solution.
 - b. Proprietary acidic cleaner; apply in compliance with directions of acidic cleaner manufacturer.
 6. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 8-2A applicable to type of stain present on exposed surfaces.
- D. Protection: Provide final protection and maintain conditions in a manner acceptable to Installer that ensures unit masonry is without damage and deterioration at time of Substantial Completion.

END OF SECTION

SECTION 050520

BOLTS, WASHERS, ANCHORS, AND EYEBOLTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section describes materials and installation of anchor bolts, connecting bolts, washers, drilled anchors, epoxy anchors, screw anchors, eyebolts, and stainless-steel fasteners.

1.02 DESIGN CRITERIA

- A. Structural Connections: AISC Specification for Structural Steel Buildings 360-16.

1.03 SUBMITTALS

- A. Submit shop drawings in accordance with the General Conditions and Section 01340: Shop Drawings, Working Drawings and Samples.
- B. Submit manufacturer's catalog data and ICBO reports for bolts, washers, and concrete anchors. Show dimensions and reference materials of construction by ASTM designation and grade.

PART 2 - MATERIALS

2.01 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall be ASTM A 193, Grade B8 or ASTM F 593, Type 316. Nuts shall be ASTM A 194, Grade 8 or ASTM F 594, Type 316. Use ASTM A 194 nuts with ASTM A 193 bolts; use ASTM F 594 nuts with ASTM F 593 bolts. Provide washer for each nut and bolthead. Washers shall be of the same material as the nuts.

2.02 HARDENED STAINLESS STEEL WASHERS

- A. Washers for American Standard beams and channels shall be square or rectangular, tapered in thickness, smooth, and conforming to type 304 or 316 stainless steel.

2.03 PLAIN UNHARDENED STEEL AND STAINLESS-STEEL WASHERS

- A. Washers shall comply with ASTM F 844. Stainless steel washers shall be Type 316. Provide clipped washers where space limitations necessitate.

2.04 DRILLED ANCHORS

- A. Unless otherwise indicated in the drawings, drilled anchors shall be Type 316 stainless steel wedge anchors as manufactured by ITW Ramset/Redhead, Hilti, Simpson Strong-Tie or equal. Anchors shall have ICBO-approved testing.

2.05 EPOXY ANCHORS

- A. Epoxy anchors shall be Type 316 stainless steel threaded rod adhesive anchors. Epoxy adhesive shall comply with ASTM C 881, Type IV, Grade 3, Class B or C. Adhesive shall be Hilti RE-500-V3, or equal. Epoxy anchor assemblies shall be ICBO approved.

2.06 SCREW ANCHORS

- A. Screw anchors shall be Titan HD screw anchors by Simpson, HUS-H by Hilti, or equal.

2.07 EMBEDDED EYEBOLTS

- A. Eyebolts shall be of the welded-eye or forged type, Type 316 stainless steel.

2.08 THREADED CARBON STEEL LIFTING EYES

- A. Threaded carbon steel lifting eyes shall comply with ASTM A 489, Type 1, Style B.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

- A. Store material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.02 INSTALLING CONNECTION BOLTS

- A. Use stainless steel bolts to connect structural aluminum members. Stainless steel bolts shall conform to type 304 or 316.
- B. Install washers per AISC Specification for ASD.
- C. Bolt holes in structural members shall be 1/16 inch in diameter larger than bolt size. Measure cast-in-place bolt locations in the field before drilling companion holes in structural steel beam or assembly.
- D. Slotted holes, if required in the drawings, shall conform to AISC Specifications, Chapter J, Section J3, Table J3.1.
- E. Drive bolts accurately into the holes without damaging the thread. Protect boltheads from damage during driving. Boltheads and nuts or washers shall rest squarely against

the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, provide beveled washers to give full bearing to the head or nut. Where self-locking nuts are not furnished, bolt threads shall be upset to prevent the nuts from backing off.

- F. Bolts shall be of the length that will extend entirely through but not more than 1/4 inch beyond the nuts. Draw boltheads and nuts tight against the work. Tap boltheads with a hammer while the nut is being tightened.

3.03 INSTALLING ANCHOR BOLTS

- A. Preset bolts and anchors by the use of templates. For mechanical equipment (pumps, compressors, and blowers), do not use concrete anchors set in holes drilled in the concrete after the concrete is placed.
- B. For static items (storage tanks and heat exchangers), use preset anchor bolts or drilled anchors with ICBO report data.
- C. After anchor bolts have been embedded, protect projecting threads by applying grease and having the nuts installed until the time of installation of the equipment or metalwork.
- D. Minimum depth of embedment of drilled mechanical anchors and screw anchors shall be as recommended by the manufacturer, but no less than that shown in the drawings.
- E. Minimum depth of embedment of epoxy anchors shall be as recommended by the manufacturer, but no less than that shown in the drawings.
- F. Prepare holes for drilled and epoxy anchors in accordance with the anchor manufacturer's recommendations prior to installation.

END OF SECTION

SECTION 055100

LADDERS, STAIRS, AND STAIR NOSINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section describes materials, fabrication, and installation of ladders, prefabricated alternating tread stairs, stair nosings, and stair treads.

1.02 DESIGN CRITERIA

- A. Handrails, Walkways, Ladders, and Personnel Platforms: OSHA, FBC.

1.03 SUBMITTALS

- A. Submit shop drawings and signed and sealed calculations in accordance with the General Conditions and Section 01340.
- B. Submit drawings of stairs, ladders, and stair nosings. Show dimensions and reference materials of construction by ASTM designation and grade.

PART 2 - MATERIALS

2.01 INCLINED ALUMINUM LADDERS WITH BUILT-IN HANDRAIL

- A. Ladders shall be aluminum construction: Alloy 6061-T6, mill finish. Clear width of stair treads shall be 24 inches. Provide 1-1/2-inch diameter handrails. Provide 6-inch by 2-inch by 1/8-inch minimum channel stringers. Provide minimum 4-1/8-inch by 1/4-inch minimum rung able to withstand a 1,000-pound load. Provide minimum 3/16-inch thick aluminum wall and floor brackets. Provide 1/12-inch aluminum handrails. Manufacturer: O'Keefe's, Inc., Model 523-10, or equal.

2.02 ALUMINUM ABRASIVE STAIR NOSINGS

- A. Abrasive stair nosings for concrete stairs shall be aluminum (Alloy 6061T6) angles 2-1/2 inches by 2-1/2 inches by 8 inches less than the concrete width. The walking surfaces of the nosings shall have integrally cast abrasive grit to provide antislip protection. Front edge of nosings shall be rounded. Nosings shall include concrete anchors. Nosings shall be American Abrasive Metals Company Curb Bar CB2, Barry Craft CB25A, or equal.

2.03 STAIR TREADS

- A. Stair treads shall be of aluminum design with 1-1/4-inch by 3/16-inch bars spaced 1-3/16 inches on center. Treads shall have extruded aluminum corrugated nosings. Treads shall be as manufactured by Grating Pacific, IKG Industries, or equal.

2.04 WELDING ELECTRODES

- A. Welding electrodes for structural steel shall conform to AWS A5.5. Use electrodes in the E-70 series.
- B. Welding electrodes for aluminum shall be ER4043 filler metal.
- C. Welding electrodes for stainless steel shall conform to AWS 5.4. Use Electrodes E308 for Type 304 stainless steel and E316 for Type 316L stainless steel.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

- A. Store structural material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.02 INSTALLING LADDERS

- A. Mount ladders to provide clearance in back of ladder so that the distance from the centerline of rungs, cleats, or steps to the nearest permanent object in back of the ladder shall be not less than 7 inches.

3.03 INSTALLING ANCHOR BOLTS - SEE SECTION 05052.

3.04 REPAIR OF GALVANIZED SURFACES

- A. Clean damaged surfaces per SSPC SP-1 and SP-11. Coating System: Apply Z.R.C. Galvanizing Compound, RAMCO Specialty Products "Zinckit," NuWave "Galv-Match-Plus," Devcon "Cold Galvanizing," Clearco "Cold Galvanizing Spray," Tnemec Series 1 Omnithane, or equal to a minimum dry-film thickness of 3 mils. Apply per ASTM A780, Annex A2. Corrosion Protection for Aluminum Surfaces
- B. Coat aluminum surfaces to be embedded or which will be in contact with concrete or masonry per Section 05121: Miscellaneous Structural Stainless Steel and Aluminum, before installation. Allow the coating to dry before the aluminum is placed in contact with the concrete.
- C. Where aluminum surfaces come in contact with dissimilar metals, keep the dissimilar metallic surfaces from direct contact by use of neoprene gaskets or washers.

END OF SECTION

SECTION 055200

HANDRAILS AND SAFETY CHAINS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section describes materials, fabrication, and installation of aluminum handrail and safety chains.

1.02 DESIGN CRITERIA

- A. Handrails, Walkways, Ladders, Personnel Platforms: OSHA, FBC.

1.03 SUBMITTALS

- A. Submit shop drawings and signed and sealed calculations in accordance with the General Conditions and Section 01340: Submit Shop Drawings, Working Drawings, and Samples.
- B. Submit drawings of handrail and safety chains. Show dimensions and reference materials of construction by ASTM designation and grade. Show design criteria.
- C. Submit placing or erection drawings that indicate locations of handrail and safety chains. Reproductions of contract documents will not be accepted for this purpose.

PART 2 - MATERIALS

2.01 ALUMINUM HANDRAILS

- A. Construct aluminum handrails of clear anodized aluminum pipe conforming to ASTM B429, Alloy 6063-T6. Handrail shall be CV Pipe Rail by Craneveyor, Wesrail as manufactured by Moultrie Manufacturing Co., or equal.
- B. Railing shall be shop assembled in sections as long as practical but shall not be greater than 24-ft in length. A field splice shall be used when an assembled section is to be attached to another section. Field splices shall be used in all railing panels that cross over structure expansion joints.
 - 1. Field splices shall use internal splice sleeves located within 8-in of railing posts. The sleeve shall be welded to the rail on one side and fastened with a set screw to the rail on other side. The field splice shall be detailed to take the differential expansion between the railing system and the supporting structure.
 - 2. When the field splice occurs in a railing panel crossing a structure expansion joint, the sleeve shall be welded to the rail on one side and be free to slide in

the rail on other side. The field splice shall be detailed to take the same movement as the structure expansion joint.

2.02 STAINLESS STEEL HANDRAIL SAFETY CHAINS

- A. Handrail safety chains shall be Type 316 stainless steel. Chains shall be proof coil style, 3/16 inch in diameter, with at least 12 links per foot and with snaphooks at each end. Snaphooks shall be Type 316 stainless steel.

2.03 WELDING ELECTRODES

- A. Welding electrodes for structural steel shall conform to AWS A5.5. Use electrodes in the E-70 series.
- B. Welding electrode for aluminum shall be ER4043 filler metal.
- C. Welding electrodes for stainless steel shall conform to AWS 5.4. Use Electrodes E308 for Type 304 stainless steel and E316 for Type 316L stainless steel.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

- A. Store material above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion. Aluminum in contact with concrete should be coated with bituminous.

3.02 FABRICATION AND ERECTION

- A. Clean the surfaces of metalwork to be in contact with concrete of rust, dirt, grease, and other foreign substances before placing concrete.
- B. Set embedded metalwork accurately in position when concrete is placed and support it rigidly to prevent displacement or undue vibration during or after the placement of concrete. Unless otherwise specified, where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with Section 03300.

3.03 WELDING

- A. Perform welding on steel by the SMAW process. Welding shall conform to the AWS D1.1-2006, except as modified in AISC Section J2.
- B. Perform welding on aluminum by the gas metal arc (MIG) or gas tungsten arc (TIG) process. Welding shall conform to the AWS D1.2-2003.

- C. Perform welding on stainless steel by the gas tungsten arc (TIG) process. Welds shall be full penetration and smooth. Provide inert gas on the inside of pipe during welding to reduce oxidation.
- D. Provide a minimum of two passes for metal thickness in excess of 5/16-inch thickness.
- E. Produce weld uniform in width and size throughout its length with each layer of weldment smooth; free of slag, cracks, pinholes, and undercuttings; and completely fused to the adjacent weld beads and base metal. Avoid irregular surface, nonuniform bead pattern, and high crown. Form fillet welds of the indicated size of uniform height and fully penetrating. Accomplish repair, chipping, and grinding of welds in manner that will not gouge, groove, or reduce the base metal thickness.

3.04 INSTALLING HANDRAILS

- A. Provide handrail components to complete the installation for the various types of handrail.

3.05 INSTALLING SAFETY CHAINS

- A. Provide two chains 4 inches longer than the access opening for each opening. Mount the top chain 3 feet 6 inches above the floor and mount the lower chain 2 feet above the floor.

3.06 CORROSION PROTECTION FOR ALUMINUM SURFACES

- A. Coat aluminum surfaces to be embedded or which will be in contact with concrete or masonry per Section 05121: Miscellaneous Structural Stainless Steel and Aluminum, before installation. Allow the coating to dry before the aluminum is placed in contact with the concrete.
- B. Where aluminum surfaces come in contact with dissimilar metals, keep the dissimilar metallic surfaces from direct contact by use of neoprene gaskets or washers.

END OF SECTION

SECTION 055300

GRATING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section describes materials, fabrication, and installation of aluminum grating.

1.02 DESIGN CRITERIA

- A. Grating: Design live load of 100 psf, maximum deflection of 1/240 of span or ¼" Maximum.

1.03 SUBMITTALS

- A. Submit shop drawings in accordance with the General Conditions and Section 01340 Shop Drawings, Working Drawings, and Samples.
- B. Submit drawings of gratings. Show dimensions and reference materials of construction by ASTM designation and grade. Show design criteria.
- C. Submit placing or erection drawings that indicate locations of fabricated items. Reproductions of contract documents will not be accepted for this purpose.

PART 2 - MATERIALS

2.01 DESIGN OF GRATING

- A. Grating Shall be as detailed in the drawings or, if not detailed, shall be designed per subsection on "Design Criteria" in Part 1. No single piece of grating shall weigh more than 80 pounds. Length of individual pieces shall not exceed one and one-half times the width, unless limited by the installation.
- B. Field measure grating for proper cutouts and size.
- C. Grating shall be completely banded. For pipe and conduits (including electrical conduit) larger than 1 inch in diameter penetrating grating, cut and band grating before galvanizing.

2.02 ALUMINUM SHEET

- A. Aluminum sheet shall conform to ASTM B209, Alloy 3003, H 14 temper.

2.03 GRATING

- A. Grating shall be aluminum (Alloy 6061 or 6063, Temper T6, as indicated in the drawings. Main bars shall be of the thickness and of the depth indicated in the drawings.

2.04 FRAMES AND SUPPORTS FOR GRATING

- A. Fabricated frames and supports for grating shall be aluminum or as indicated in the drawings. Corners of embedded angle frames shall be mitered and welded with the welds ground smooth.

2.05 WELDING ELECTRODES

- A. Welding electrodes for structural steel shall conform to AWS A5.5. Use electrodes in the E-70 series.
- B. Welding electrode for aluminum shall be ER4043 filler metal.
- C. Welding electrodes for stainless steel shall conform to AWS A5.4. Use electrodes as follows:

Stainless Steel Material	Welding Electrode Material
Type 304	E 308
Type 304L	E 347
Type 316	E 316
Type 316L	E 318

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

- A. Store structural material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.02 INSTALLATION AND ERECTION

- A. Clean the surfaces of metalwork to be in contact with concrete of rust, dirt, grease, and other foreign substances before placing concrete.
- B. Set grating seats and frames and checkered plate frames and supports accurately in position when concrete is placed and support it rigidly to prevent displacement or undue vibration during or after the placement of concrete. Unless otherwise specified, where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with Section 03300 Concrete.

- C. Set seat angles for grating so that the grating will be flush with the floor. Maintain the grating and floor plates flush with the floor. Seat angles and anchors shall be aluminum or as indicated in the drawings.

3.03 FASTENING

- A. Fasten grating panels to supporting members as indicated in the drawings. Saddle clips shall be the same material as the grating.

3.04 GALVANIZING

- A. Zinc coating for plates, bolts, anchor bolts, and threaded parts shall be in accordance with ASTM A 153.

3.05 WELDING

- A. Perform welding on steel by the SMAW process. Welding shall conform to AWS D1.1-2006, except as modified in AISC Section J2.
- B. Perform welding on aluminum by the gas metal arc (MIG) or gas tungsten arc (TIG) process. Welding shall conform to AWS D1.2-2003.
- C. Perform welding on stainless steel by the gas tungsten arc (TIG) process. Welds shall be full penetration and smooth. Provide inert gas on the inside of pipe during welding to reduce oxidation.
- D. Provide a minimum of two passes for metal thickness in excess of 5/16-inch thickness.
- E. Produce weld uniform in width and size throughout its length with each layer of weldment smooth; free of slag, cracks, pinholes, and undercuttings; and completely fused to the adjacent weld beads and base metal. Avoid irregular surface, nonuniform bead pattern, and high crown. Form fillet welds of the indicated size of uniform height and fully penetrating. Accomplish repair, chipping, and grinding of welds in manner that will not gouge, groove, or reduce the base metal thickness.

3.06 CORROSION PROTECTION OF ALUMINUM SURFACES

- A. Coat aluminum surfaces to be embedded or which will be in contact with concrete or masonry per Section 05121: Miscellaneous Structural Stainless Steel and Aluminum before installation. Allow the coating to dry before the aluminum is placed in contact with the concrete.
- B. Where aluminum surfaces come in contact with dissimilar metals, keep the dissimilar metallic surfaces from direct contact by use of neoprene gaskets or washers.

END OF SECTION

SECTION 099000

HIGH PERFORMANCE PAINTS AND COATINGS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
 - a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines- Enamel and Tape-Hot-Applied.
 - b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
 - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
 2. Environmental Protection Agency (EPA).
 3. International Concrete Repair Institute (ICRI) Guideline No. 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 4. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 5. ANSI / NSF International (NSF): 61, Drinking Water System Components- Health Effects.
 6. National Association of Pipe Fabricators (NAPF)
 - a. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
 7. Occupational Safety and Health Act (OSHA).
 8. The Society for Protective Coatings (SSPC):
 - a. SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
 - b. SSPC-PA 3, Guide to Safety in Paint Applications.
 - c. SSPC-SP 1, Solvent Cleaning.
 - d. SSPC-SP 2, Hand Tool Cleaning.
 - e. SSPC-SP 3, Power Tool Cleaning.
 - f. SSPC-SP 5/NACE 1, White Metal Blast Cleaning.
 - g. SSPC-SP 6/NACE 3, Commercial Blast Cleaning.
 - h. SSPC-SP 7, Joint Surface Preparation Standard Brush-Off Blast

- Cleaning.
 - i. SSPC-SP 10/NACE 2, Near-White Blast Cleaning.
 - j. SSPC-SP 11, Power Tool Cleaning to Bare Metal.
 - k. SSPC-SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
 - l. SSPC-SP 13/NACE 6, Surface Preparation of Concrete.
 - m. SSPC-SP 16, Brush-off Blast cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
 - n. Guide 15, Field Methods for Retrieval and Analysis of Soluble Sa1ts on Steel and Other Nonporous Substrates.
 - o. SSPC-TU 11, Inspection of Fluorescent Coating Systems.
9. National Fire Protection Association (NFPA).
10. American Society for Testing and Materials (ASTM International).

1.02 SUMMARY

- A. Section Includes: Field painting as shown and/or herein required. See specific items not requiring field painting under Work Not Included.
- B. Provide all labor, materials, equipment and services for furnishing and installing the finishes as indicated on drawings and schedules, and as herein specified.
- C. In general, exposed surfaces of factory and/or shop-primed work that are delivered to Site without a final finish shall be painted. The shop priming and intermediate shop coatings shall not be considered as included in the number of field coats specified under Part 2, Field Painting Systems Article, Finish Paints paragraph in this Section.
- D. Ferrous metal surfaces, excluding stainless steel surfaces that will be exposed in the completed Work, shall be sandblasted either at the point of fabrication or under this Section prior to placement of primers. Field fabrication, including welds and cuts, shall be sandblasted, primed, and painted as herein specified.
- E. Ferrous metal items that will be in contact with precast concrete slabs, masonry, etc., shall be finish painted.
- F. Galvanized steel items that are not included under "Work Not Included," shall be prepared, primed, and finish painted as herein specified.
- G. Bruises, mars, and/or scratches in the shop painting due to handling, shall be immediately touched up in the field by Contractor prior to any storage or installation.
- H. Work includes field painting of exposed bare and covered pipes and ducts (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work, except as otherwise indicated.

- I. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- J. Surfaces to be Painted: Except where natural finish of material is specifically noted as a surface not to be painted, paint exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas. If color or finish is not designated, Architect-Engineer will select these from standard colors or finishes available.
- K. Painting of piping includes pipe hangers, valves, and piping accessories, and also includes surfaces that will be in contact with piping supports. ALL PIPING SHALL BE COMPLETELY PAINTED.
- L. Existing surfaces shall be painted where shown and/or called for. Preparation for repainting and priming shall be as herein specified.
- M. Altered existing Work or damaged surfaces that are a result of the revisions shall be painted under this item of Work. The finishes shall match the existing adjacent coatings.
- N. Miscellaneous equipment shipped to Site with factory-applied coatings as follows, shall be painted under this Work as specified:
 - 1. No Factory Finish: Surface preparation, priming, and finish painting.
 - 2. Prime Coat: Surface preparation, touch-up, and finish painting.
 - 3. Intermediate Coat: Surface preparation, touch-up, and finish painting.
 - 4. Pre-finished Equipment: Touch-up as required. Equipment manufacturer shall furnish necessary touch-up paint.
 - 5. Factory finish coats, not matching the approved finish colors, that are provided in lieu of the shop prime specified shall be properly prepared and receive a final field coat to match the adjacent related Work.
- O. Painting as called for on Drawings is for guidance only and does not limit the requirements for painting.
- P. Work Not Included: Unless specifically called for on Drawings or specified in this Section, the following are not included:
 - 1. Exterior exposed concrete surfaces and exterior exposed concrete surfaces below the ground floor plan.
 - 2. Nonferrous metals and stainless steel, except copper and brass.
 - 3. Exterior aluminum siding.

4. Nonexposed surfaces of treated lumber.
5. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces, and duct shafts.
6. Conduits below the main floor, except in rooms that are painted.
7. Exterior gratings with a hot-dipped galvanized finish.
8. Manufacturer's name and identification plates, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
9. Overhead sectional doors - shall have a factory finish on both interior and exterior exposed surfaces.
10. All interior and exterior sealant and caulking unless adjacent to latex-coated surfaces and approved by Engineer.
11. Interior concrete surfaces of tanks and basins, immersed and exposed not to be painted.
12. Operating Parts: Unless otherwise indicated, moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motors, and fan shafts will not require finish painting.

1.03 DEFINITIONS

A. Terms used in this section:

1. ASTM D 16, unless otherwise specified.
2. Coverage: total-minimum dry film thickness in mils or square feet per gallon.
3. DFT: Dry Film Thickness – Thickness of a coat of cured paint measured in mils (1/1000 inch).
4. FRP: Fiberglass Reinforced Plastic.
5. HCl: Hydrochloric Acid.
6. MDFT: Minimum Dry Film Thickness, mils.
7. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
8. Mil: Thousandth of an inch.
9. PDS: Product Data Sheet.

10. PSDS: Paint System Data Sheet.
11. PVC: Polyvinyl Chloride.
12. SFPG: Square Feet per Gallon.
13. SFPGPC: Square Feet per Gallon per Coat.
14. SP: Surface Preparation.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit in accordance with Division 1 Submittal Procedures.

a. Data Sheets:

- 1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
- 2) For each paint system, furnish a Paint System Data Sheet (PSDS).
- 3) Technical and performance information that demonstrates compliance with Specification.
- 4) Furnish copies of paint system submittals to the coating applicator.
- 5) Indiscriminate submittal of only manufacturer's literature is not acceptable.

- b. Detailed chemical and gradation analysis for each proposed abrasive material.

2. Samples:

- a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.

b. Reference Panel:

1) Surface Preparation:

- a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
- b) Provide panel representative of the steel used; prevent deterioration of surface quality.
- c) Panel to be reference source for inspection upon approval by Engineer.

2) Paint:

- a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
- b) Furnish additional samples as required until colors, finishes, and textures are approved.
- c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

- 1. Typewritten schedule of Painting Operations. This schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and number of coats in order to achieve the specified dry film thickness, and color charts.
- 2. Coating manufacturer's Certificate of Compliance, in accordance with Division 1, Manufacturers' Field Services.
- 3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
- 4. Manufacturer's written verification that submitted material is suitable for the intended use.
- 5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
- 6. Manufacturer's written instructions and special details for applying each type of paint.

C. Warranty:

- 1. Submit manufacturer's standard warranty in accordance with requirements of Division 1, warranties covering the items included under this Section.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

- 1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
- 2. Perform surface preparation and painting in accordance with recommendations of the following:

- a. Paint manufacturer's instructions.
- b. SSPC PA 3, Guide to Safety in Paint Applications.
- c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

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

D. Pre-application Meeting:

- 1. Convene a pre-application meeting two [2] weeks before start of application of coating systems. Require attendance of parties directly affecting work of this section, including Contractor, Engineer, applicator, and manufacturer's representative. Review the following:
 - a. Environmental requirements.
 - b. Protection of surfaces not scheduled to be coated.
 - c. Surface preparation.
 - d. Application.
 - e. Repair.
 - f. Field quality control.
 - g. Cleaning.
 - h. Protection of coating systems.
 - i. One-year inspection.
 - j. Coordination with other work.

E. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

F. Coordination of Work: Review other sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings systems for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

- 1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.

2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.
- B. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
1. Name or title of material.
 2. Fed. Spec. number, if applicable.
 3. Manufacturer's stock number, batch number, and date of manufacturer.
 4. Manufacturer's name.
 5. Contents by volume, for major pigment and vehicle constituents.
 6. Thinning instructions.
 7. Application instructions.
 8. Color name and number.
- C. Storage:
1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
 2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.
 3. Handling: Protect materials during handling and application to prevent damage or contamination.
 4. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.07 PROJECT CONDITIONS

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

5 degrees F above dew point of ambient air.

3. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
4. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
5. Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted or restricted by paint manufacturer's printed instructions. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.
6. Paint only when the surface temperature is at least 5 degrees F above the dew point, unless otherwise permitted by paint manufacturer's printed instructions.

B. Status of Existing Coatings:

1. Perform tests as required to verify condition of existing coatings and substrate conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.
- B. Minimum of 5 years' verifiable experience in manufacture of specified product.
- C. Each of the following manufacturers is capable of supplying most of the products specified herein:
 1. TNEMEC Company, Inc.
 2. The Sherwin-Williams Company.
 3. PPG Industries.
 4. Carboline.

2.02 ABRASIVE MATERIALS

- A. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.
- B. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

- A. General:
 - 1. Manufacturer's highest quality products suitable for intended service. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.
 - 2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
 - 3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.
 - 4. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.
 - a. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry film) of paint by weight.

B. Products:

Product	Definition
Acrylic Latex	Single-component, 100% acrylic finish as required
Block Filler	Primer-sealer designed for rough masonry surfaces, acrylic emulsion, cementitious acrylic, or epoxy
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type, suitable for immersion service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surface, nonshrinking, suitable for application to concrete and masonry
Epoxy Nonskid (Aggregated)	100% solids two-component catalyzed epoxy aggregated; aggregate may be packaged separately
Epoxy Primer-Ferrous Metal	High-build, two-component catalyzed epoxy primer.
Epoxy Primer- Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated

Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA
High Build Epoxy	High-build, two-component catalyzed epoxy, capability of 3 to 5 MDFT per coat
Epoxy Novolac	100% solids two-component, highly chemical resistant epoxy
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats.
Gloss Polyurethane -	Two-component, aliphatic acrylic based polyurethane; high gloss finish
Multipolymeric Matrix Coating	Heat resistant single component inert multipolymeric matrix coating for high heat applications under insulation.
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required.

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

1. Colors: Formulate paints with colorants for reasons of color or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

- A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.
- B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.
- C. Shop Coating Requirements:
 - 1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
 - 2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.
- D. Pipe:
 - 1. Steel and Ductile Iron Pipe:
 - a. Prepare steel surfaces in accordance with SSPC SP-6, Commercial Blast Cleaning with a surface profile of 2 to 3 MILS.
 - 1) Prepare ductile or cast iron surfaces in accordance with NAPF 500-03-04 Abrasive Blast Cleaning with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain. Bituminous coated pipe shall NOT be allow if field painting is required.
 - 2) Bituminous coated pipe shall NOT be allow if field painting is required.
 - 3) Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
 - b. The surface preparation and application of the primer shall be performed by pipe manufacturer.
 - c. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
- B. Perform the Work only in presence of Engineer or their representative, unless Engineer grants prior approval to perform the Work in Engineer's absence.
- C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.
- D. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect-Architect-Engineer. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations. At completion of work of other trades, touch up and restore all damaged or defaced painted surfaces.

3.02 EXAMINATION

- A. Factory Finished Items:
 - 1. Scheduling Inspection with Engineer before repairing damaged factory finished items delivered to Site.
 - 2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.
- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.
- C. Starting of painting work will be construed as acceptance of surfaces and conditions within any particular area.
- D. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

- A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition, or as required by this specification, the more stringent requirements shall apply.
 - 1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect-Architect-Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.
 - 2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.
 - 3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning per SSPC SP-1. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.
 - 4. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.
 - 5. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
- B. Field Abrasive Blasting:
 - 1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
 - 2. Refer to coating systems for degree of abrasive blasting required.
 - 3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.
- C. Metal Surface Preparation:
 - 1. Where indicated, meet requirements of SSPC Specifications summarized below:

- a. SSPC-SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
 - b. SSPC-SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
 - c. SSPC-SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
 - d. SSPC-SP 5/NACE 1, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
 - e. SSPC-SP 6/NACE 3, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
 - f. SSPC-SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
 - g. SSPC-SP 10/NACE 2, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides: corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
 - h. SSPC-SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
 - i. SSPC-SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high- pressure and ultrahigh-pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ-1 through WJ-4 for visual surface preparation definitions and SC-1 through SC-3 for nonvisual surface preparation definitions.
2. The words "solvent cleaning", "hand tool cleaning", "wire brushing", and "blast cleaning", or similar words of equal intent in these Specifications or in paint manufacturer's specification refer to the applicable SSPC Specification.
 3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.

4. Hand tool clean areas that cannot be cleaned by power tool cleaning.
5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
6. Welds and Adjacent Areas:
 - a. Prepare such that there is:
 - 1) No undercutting or reverse ridges on weld bead.
 - 2) No weld spatter on or adjacent to weld or any area to be painted.
 - 3) No sharp peaks or ridges along weld bead.
 - b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
7. Pre-blast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
8. Blast Cleaning Requirements:
 - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
 - b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
 - c. Use only dry blast cleaning methods.
 - d. Do not reuse abrasive, except for designed recyclable systems.
 - e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
9. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
 - b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Prepare galvanized steel and nonferrous metal surfaces in accordance with SSPC-SP16 and the coating manufacturer's instructions.
2. Test galvanized surfaces for chromate treatments and remove as required by SSPC-SP 16, or other Engineer approved method.
3. Ensure surfaces are dry.

E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13/NACE 6 and ICRI 310.2.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.
4. Abrasive blast clean to remove loose concrete and laitance, and provide an ICRI CSP profile as required by paint manufacturer.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry

Prior to painting. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method, and, if necessary, ASTM F1869, Measuring Moisture Vapor Emission Rate of Concrete. Do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
7. If surfaces are found to be sufficiently alkaline to cause blistering and burning off of finish paint, correct this condition before application of paint.

F. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.

2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
 - a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
 - b. Brush-off blasting.
 - c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Engineer prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
 - a. Synthetic-based wood putty approved by paint manufacturer for paint system.
 - b. For natural finishes, color of wood putty shall match color of finished wood.
 - c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
 - d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
 - e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

6. Prime, stain, or seal wood required to be job-painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling.
- I. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.
 1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.
- J. Galvanized Surfaces: SSPC SP 16.
- K. Existing Painted Surfaces to be Repainted Surface Preparation:
 1. Detergent wash and freshwater rinse.
 2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
 3. Feather surrounding intact coating.
 4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
 5. Apply one full finish coat of specified primer to entire surface.
 6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
 7. For ductile iron pipe with asphaltic varnish finish not specified to be abrasive blasted, apply coat of tar stop prior to application of cosmetic finish coat.
 8. Application of Cosmetic Coat:
 - a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
 - b. Check compatibility by application to a small area prior to starting painting.
 9. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.
- L. Shop Primed Surfaces: Prepare shop-applied prime coats wherever damaged or bare as required by other sections of these Specifications. Clean and touch-up with same type shop primer.

3.05 SURFACE CLEANING

- A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
 2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
 3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
 4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
 5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
 6. Repair or replace surface damaged by blast cleaning.
- C. Solvent Cleaning:
1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
 2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for existing and new interior masonry, interior and exterior wood, and metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.
13. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.

14. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
15. Paint back sides of access panels, and removable or hinged covers to match exposed surfaces.
16. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to those items exposed in mechanical equipment rooms and in occupied spaces.
 - a. Piping, pipe hangers, supplementary steel and supports (except galvanized surfaces).
 - b. Heat exchangers.
 - c. Tanks.
 - d. Ductwork, insulation.
 - e. Motor, mechanical equipment, and supports.
 - f. Accessory items.
 - g. Conduits and fittings (except galvanized surfaces).
 - h. Switchgear.
 - i. Hanger and support (except galvanized surfaces).
17. Provide finish coats which are compatible with prime paints used.
18. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
19. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable. Holiday test coated steel in immersion areas in accordance with NACE International RP 0188-90.
20. Transparent (Clear) Finishes: Use multiple coats to produce glass smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.
21. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.

2. Prepare surface and apply primer in accordance with System No. 5 specification.
 3. Apply intermediate and finish coats of the coating system appropriate for the exposure.
- C. Porous Surfaces, Such As Concrete and Masonry:
1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
 2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
 - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
 3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.
- D. Film Thickness and Coverage:
1. Number of Coats:
 - a. Minimum required without regard to coating thickness.
 - b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
 2. Application Thickness:
 - a. Do not exceed coating manufacturer's recommendations.
 - b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
 3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
 - a. Perform with properly calibrated instruments.
 - b. Recoat and repair as necessary for compliance with Specification.
 - c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
 4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
 5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.

6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.
- B. The Finish Schedule on Architectural Drawings addresses walls, floors and ceilings for various buildings. Additional requirements are included in the following schedule which addresses structural steel, prefabricated steel trusses, process equipment, pumps, piping and other items.
- C. NSF International approval required for coatings used in contact with the water treatment plant process water.
- D. System No. 1 – Not Used:
- E. System No. 2 Exposed Metal-: Exterior

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 6/NACE 3, Commercial Blast Cleaning with a surface profile of 2 to 3 MILS.	Epoxy Primer- Ferrous Metal	1 coat, 3 to 5 MDFT
	High Build Epoxy	1 coat, 3 to 5 MDFT
	Gloss Polyurethane	1 coat, 2 to 4 MDFT

1. Use on the following items or areas:

Exposed metal surfaces, new and existing located outside of structures and exposed to weather, and the following specific surfaces:

- 1) Exposed metal surfaces, piping and equipment in the headworks.
- 2) Exposed process piping above grade and within structures or vaults.

- F. System No. 3 Exposed Metal-: Interior

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 6/NACE 3, Commercial Blast	Epoxy Primer- Ferrous Metal	1 coat, 3 to 5 MDFT
	High Build Epoxy	1 coat, 3 to 5 MDFT

Cleaning with a surface profile of 2 to 3 MILS	High Build Epoxy	1 coat, 3 to 5 MDFT

2. Use on the following items or areas:

Exposed metal surfaces, new and existing located inside of structures and the following specific surfaces:

- 1) Exposed metal surfaces, piping and equipment in the headworks.
- 2) Exposed process piping above grade and within structures or vaults.

- G. System No. 4 Buried Steel (Soil Side)

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 10/NACE 2, Near White Blast Cleaning	Coal Tar Epoxy	1 or 2 coats, 14.0 – 20.0 MDFT Total

- H. System No. 5 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 16	Epoxy Primer- Other	As recommended by coating manufacturer, Ext. Topcoat: Gloss Polyurethane 1 coat, 2 to 4 MDFT Intermediate Topcoat: High Build Epoxy 1 coat, 3 to 5 MDFT

1. Use on the following items or areas:

- a. Galvanized surfaces requiring painting.
- b. After application of System No. 4, apply finish coats as required for exposure.

- I. System No. 6 Carbon Steel or Stainless Steel – Atmospheric or Insulated Service:: Ambient or Hot Steel up to 500 degrees F (260 degrees C)

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 10/NACE 2, Near-White Blast Cleaning	Multipolymeric-Matrix Coating	2 coats, 5 MDFTPC

1. Use on the following items or areas:
 - a. High heat applications for carbon steel or stainless steel.
 - b. Application surface temperatures from ambient to 1,000 degrees F (537 degrees C).
 - c. Operating surface temperatures cryogenic to 1200 degrees F (649 degrees F).
 - d. Self-priming, single component.

J. System No. 7 Skid-Resistant- Concrete Floors:

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Epoxy Nonskid (Aggregated)	1 coat, 160 SFPG 10 MDFT plus aggregate

1. Use on the following items or areas:
 - a. Use on the interior floor of the pump station building, except floors within chemical storage and feed areas.

K. System No. 8 Buried Concrete (Soil Side) – where indicated on drawings.

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Coal Tar Epoxy	1 or 2 coats, 16.0 – 24.0 MDFT Total

L. System No. 9 Skid-Resistant- Concrete for above grade slabs or where slab moisture content is unknown:

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Water based Breathable Self-leveling Epoxy with Nonskid Aggregated added	2 coats, total 10 MDFT plus aggregate to Owner desired texture

M. System No. 10.1 Chemical Resistant Concrete Floor / Wall / Secondary Containment (moderate chemical exposure)

Surface Prep	Paint Material	Min. Coats, Cover

SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	100% Solids Flake-Filled Epoxy Novolac	Manufacturer Recommended Primer – 4.0 to 6.0 mils DFT 2 coats – 15.0 – 20.0 mils DFT

Verify resistance to stored commodities and anticipated traffic load PRIOR to installation.

- N. System No. 10.2 Chemical Resistant Concrete Floor / Wall / Secondary Containment (hazardous chemical exposure)

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Urethane Cement Vapor Barrier / Surfacer	Manufacturer Recommended Primer – 4.0 to 6.0 mils DFT 2 coats – 15.0 – 20.0 mils DFT
	Flake Filled Vinyl Ester Coating	2 coats, 15.0 – 20.0 mils DFT/coat: 30.0-40.0 mils total

Verify resistance to stored commodities and anticipated traffic load PRIOR to installation.

- O. System No. 11 Chemical-Resistant Wall / Floor, Heavy-Duty- Concrete and Masonry:

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Epoxy Filler/Surfacer.	1 coat, as required to fill voids and bugholes to provide a continuous substrate
	100% Solids Epoxy Novolac	2 or 3 coats, 10.0 – 14.0 mils DFT Total

1. Use on the following items or areas:
 - a. Walls and floors for chemical containment areas.
 - b. Walls and floors for chemical storage and feed areas.
 - c. Interior base slabs and walls for chemical piping pull boxes and chemical injection vault.

P. System No. 12- Not Used.

Q. System No. 13 – Not Used.

R. System No. 14 Aluminum and Dissimilar Metal Insulation:

Surface Prep	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Coal-Tar Epoxy	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete.

S. System No. 15 Interior Concrete and Masonry Walls, Non-immersion, excluding Floors:

Surface Prep	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete and Masonry Surface Preparation	Manufacturer Recommended Surfer or Block Filler	1 coat, as required to fill voids
	Two Component Water Based Catalyzed Epoxy	2 coats, total 5.0 – 8.0 MDFT

1. Use on the following items or areas:
 - a. Concrete and concrete block walls, columns and supports.
 - b. Concrete ceilings and beams.
 - c. Non-corrosive room areas.

T. System No.16 Interior Gypsum Wallboard:

Surface Prep	Paint Material	Min. Coats, Cover
In accordance with Paragraph Interior Gypsum Board Surface Preparation	Latex Primer Sealer	1 coat, 1.5 MDFT
	Acrylic Latex	2 coats, 1.5 MDFT

1. For interior gypsum wallboard (walls and ceilings).

- U. System No. 17 Exposed FRP, PVC Plastic Piping, Valves, Fittings, and Conduit, Interior and Exterior

Surface Prep	Paint Material	Min. Coats, Cover
In accordance with Paragraph 3.02 Surface Preparation, including cleaning and washing with detergent to remove all dirt and foreign material, and light surface abrasion using medium grade sandpaper. Remove dust, dirt and debris with clean rags prior to coating.	Two component epoxy. Hi-Build Epoxy	1 coat, 3.0 MDFT 1 coat, 3.0 MDFT Total min. system coating thickness: 6.0 MDFT

1. For PVC or fiberglass piping or electrical systems requiring color coding, and for protection of exposed, exterior plastic components from the elements, and shall include the following:
 - a. PVC and fiberglass piping, fittings, valves, and electrical conduits requiring color coding in accordance with Section 99050: Piping, Valve, and Equipment Identification System.
 - b. Exposed exterior plastic piping, valve, and fitting components subject to UV degradation and weathering by the elements.

- V. System No. 18 – Not Used.

- W. System No. 19 – Not Used.

3.08 COLORS

- A. Provide as shown for equipment and appurtenances and designated herein and shown in Piping Schedule.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.
- C. Equipment Colors:
 1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
 2. Paint equipment and piping one color as selected.

3. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
 - a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
 - b. Fire Protection Equipment and Apparatus: OSHA Red.
 - c. Radiation Hazards: OSHA Purple.
 - d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

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

3.09 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Testing:

1. Thickness and Continuity Testing by Contractor:
 - a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for

correct millage. Do not make measurement before a minimum of 8 hours after application of coating.

- b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
 - c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
 - d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.
- C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.
- D. Unsatisfactory Application:
1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
 2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
 3. Repair defects in accordance with written recommendations of coating manufacturer.
- E. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.
- F. The right is reserved by Owner to invoke the following material testing procedure at any time, and any number of times during period of field painting:
1. Engage services of an independent testing laboratory to sample paint being used. Samples of materials delivered to project site will be taken, identified and sealed, and certified in presence of Contractor.
 2. Testing laboratory will perform appropriate tests for any or all of following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated

yellowness, recoating, skinning, color retention, alkali resistance and quantitative materials analysis.

- G. If test results show that material being used does not comply with specified requirements, Contractor may be directed to stop painting work, and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.

3.10 MANUFACTURER'S SERVICES

- A. In accordance with Division 1, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:
 - 1. On first day of application of any coating system.
 - 2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
 - 3. As required to resolve field problems attributable to or associated with manufacturer's product.
 - 4. To verify full cure of coating prior to coated surfaces being placed into immersion service.
 - a. Inspection Reports: Submit written reports to Engineer and Contractor describing inspections made and actions taken to correct nonconforming work. Report nonconforming work not corrected.
 - b. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.11 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.
- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.
- D. As soon as painting Work is accepted by Contractor, it shall become its responsibility for protection, final cleaning, and touch-up. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color. Repair coating defects in accordance with manufacturer's written instructions.

- E. Upon completion of painting work, clean window glass and other paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.12 ONE-YEAR INSPECTION

- A. Owner will set date for one-year inspection of coating systems.
- B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.
- C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer's instructions.

3.13 STENCILING

- A. The Contractor shall supply all materials and labor necessary for stenciling of legends on pipes. The legend shall show the name of the contents. Review by the Architect-Engineer of legends will be required. Names shall be "plainly visible". Arrows showing direction of flow shall also be stenciled on pipes. The legends shall be located not more than 10 feet apart and, in general, at each valve and piece of equipment. The size and location of the legend shall be in general accordance with ANSI A13.1-1981 "Scheme for the Identification of Piping Systems". All visible piping 6" in diameter and larger shall be color-coded and stenciled. "Stick-on" labels are not acceptable.

3.14 PLASTIC IDENTIFICATION MARKERS

- A. All visible piping 3/4" and greater and less than 6" which is accessible for maintenance operations shall be color-coded and identified with semi-rigid plastic identification markers equal to SETMARK Pipe Markers as manufactured by Seton Name Plate Corporation, New Haven, Conn.; T & B/Westline, Los Angeles, California; or equal. Direction of flow arrows are to be included on each marker, unless otherwise specified.
- B. Each marker background is to be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ANSI A 13.1 - 1981).
- C. For pipes under 3/4" O.D. (too small for color bands and legends), brass identification tags 1-1/2" in diameter with depressed 1/4" high black-filled letters above 1/3" blackfilled numbers shall be fastened securely at specified locations.
- D. All electrical conduits, which are accessible for maintenance operations, shall be identified with semi-rigid identification markers similar to those specified above.
- E. Each marker background is to be color-coded with a clearly printed legend to identify the conductor. Size of markers and sizes of lettering to generally conform to the "Scheme for Identification of Piping Systems" (ANSI A 13.1 - 1981)

F. Locations for pipe and electrical markers to be as follows:

1. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
2. Each branch and riser take-off.
3. Each pipe passage through wall, floor and ceiling construction.
4. Each pipe passage to underground.
5. All horizontal pipe runs-marked every 25 feet.

END OF SECTION

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.
- C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.25.
 - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.

4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
5. Insulation System: NEMA Class F.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
9. Sound Power Levels: Conform to NEMA MG 1.

D. Single Phase Motors:

1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115 volts, single phase, 60 Hz.

E. Electronically Commutated Motors (ECM)

1. Brushless permanent magnet motor with integral electronic control module for speed control.

F. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.02 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.01 NOT USED

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment Labels.
 - 2. Warning signs and labels.
 - 3. Pipe Labels.
 - 4. Duct Labels.
 - 5. Valve Tags.

1.02 REFERENCES

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

1.03 SUBMITTALS

- A. Product Data: For each type of product.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals submittal.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers:
 - a. Emedco.
 - b. Seton Identification Products.

- c. Substitutions: Accepted Substitution.
 - 2. Material and Thickness: 316 stainless steel, 0.025 inch minimum thickness, with predrilled or stamped holes for attachment hardware.
 - 3. Letter and Background Color: As indicated for specific application under Part 3.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch .
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 6. Fasteners: Stainless steel rivets or self-tapping screws.
 - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
- 1. Manufacturers:
 - a. Emedco.
 - b. Seton Identification Products.
 - c. Substitutions: Accepted Substitution.
 - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
 - 3. Letter and Background Color: As indicated for specific application under Part 3.
 - 4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.02 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Emedco.
 - 2. Seton Identification Products.
 - 3. Substitutions: Accepted Substitution.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless steel rivets or self-taping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS

- A. Manufacturers:
 - 1. DuraLabel.
 - 2. Emedco.
 - 3. Seton Identification Products.
 - 4. Substitutions: Accepted Substitution.
- B. Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering without fasteners or adhesive. Larger sizes may have maximum sheet size with spring fastener.
- E. Self-Adhesive Pipe Labels: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings using UV and chemical resistant inks.
- F. Minimum Letter Size: 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.04 DUCT LABELS

- A. Manufacturers:
 - 1. DuraLabel.

2. Emedco.
 3. Seton Identification Products.
 4. Substitutions: Accepted Substitution.
- B. Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Self-Adhesive Pipe Labels: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings using UV and chemical resistant inks.
- E. Minimum Letter Size: 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.05 VALVE TAGS

- A. Manufacturers:
1. Emedco.
 2. Seton Identification Products.
 3. Substitutions: Accepted Substitution.
- B. Material and Thickness: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware
- C. Label Size and Shape: As indicated for specific application under Part 3.
- D. Minimum Letter Size: Stamped or engraved 1/4 inch for piping system abbreviation and 1/2 inch for identifying valve number.
- E. Fasteners: Brass beaded chain.
- F. Valve Schedules: For each piping system, on 8-1/2 by 11 inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping, ductwork, and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 INSTALLATION, GENERAL REQUIREMENTS

- A. Install identifying devices after completion of coverings and painting.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceiling and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.
- E. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- F. Install labels with sufficient adhesive for permanent adhesion.
- G. Install tags using corrosion resistant chain. Number tags consecutively by location.
- H. Identify control panels and major control components outside panels with plastic labels.
- I. Identify valves in main and branch piping with tags.
- J. Tag automatic controls, instruments, and relays. Key to control schematic.

3.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of mechanical equipment.
- B. Sign and Label Colors:
 - 1. White letters on a black background.
- C. Locate equipment labels where accessible and visible.
- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E.

3.04 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service flow and direction.
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 ft. of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 3. Within 3 ft. of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 20 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.
- C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 2. Condenser-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 3. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 4. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.
 - 5. Low-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
 - 6. High-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
 - 7. Steam Condensate Piping: White letters on an ANSI Z535.1 safety-green background.
 - 8. Toxic and Corrosive Fluids: Black letters on an ANSI Z535.1 safety-orange background.
 - 9. Flammable Fluids: Black letters on an ANSI Z535.1 safety-yellow background.
 - 10. Combustible Fluids: White letters on an ANSI Z535.1 safety-brown background.
 - 11. Potable and Other Water: White letters on an ANSI Z535.1 safety-green background.
 - 12. Compressed Air: White letters on an ANSI Z535.1 safety-blue background.

3.05 INSTALLATION OF DUCT LABELS

- A. Install self-adhesive duct labels showing service and flow direction on air ducts.
- B. Duct Label Locations: Locate duct labels where ductwork is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each point where ducts enter into and exit from concealed spaces.
 - 2. At access doors, manholes, and similar access points that permit view of concealed ductwork.

3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 20 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

C. Duct Label Color Schedule:

1. Supply Air: White letters on an ANSI Z535.1 safety-green background.
2. Return Air: White letters on an ANSI Z535.1 safety-blue background.
3. Exhaust Air: White letters on an ANSI Z535.1 safety-blue background.
4. Outdoor Air: White letters on an ANSI Z535.1 safety-green background.

3.06 INSTALLATION OF VALVE TAGS

- A. Install valve tags on valves to allow for proper operation of the valve. Tags should be hung such that they will not slip off.

B. Valve Tag Size and Shape:

1. Chilled Water: 1-1/2 inches, round.
2. Condenser Water: 1-1/2 inches, round.
3. Refrigerant: 1-1/2 inches, round.
4. Hot Water: 1-1/2 inches, round.
5. Gas: 1-1/2 inches, round.
6. Low-Pressure Steam: 1-1/2 inches, round.
7. High-Pressure Steam: 1-1/2 inches, round.
8. Steam Condensate: 1-1/2 inches, round.

C. Valve Tag Colors:

1. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

END OF SECTION 230553

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing adjusting, and balancing of air systems.
2. Testing adjusting, and balancing of refrigerating systems.
3. Measurement of final operating condition of HVAC systems.

1.02 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. Testing Adjusting and Balancing Bureau:

1. TABB - International Standards for Environmental Systems Balance.

1.03 SUBMITTALS

- A. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- B. Test Reports: Indicate data on forms prepared following ASHRAE 111. Submit data in I.P. units.
- C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

- D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty, copy of NEBB Certificate of Conformance Certification, or TABB International Quality Assurance program guarantee.
- E. Submit draft copies of report for review prior to final acceptance of Project.
- F. Furnish reports electronically in .PDF format with digital bookmarks and page labels.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of balancing valves and rough setting.
- B. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with ASHRAE 111.
- B. Prior to commencing Work, calibrate each instrument to be used.

1.06 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC, NEBB, or TABB.

1.07 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Not Used.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. HVAC control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.

3.02 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.03 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.04 ADJUSTING

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Report defects and deficiencies noted during performance of services, preventing system balance.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- G. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air flow rate measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain:
 - 1. Space temperatures within 2 degrees F.
 - 2. Minimal objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

3.06 SCHEDULES

- A. Complete list of Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Packaged Terminal Air Conditioning Units.
 - 2. Split-System Air Conditioners.
 - 3. Fans.
 - 4. Air Inlets and Outlets.
- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency

- c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
2. Summary Comments:
- a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
3. Instrument List:
- a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
4. Electric Motors:
- a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
5. Exhaust Fan Data:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure

- i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
6. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure

END OF SECTION

SECTION 231113

FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fuel oil piping - above ground.
2. Unions and flanges.
3. Valves.
4. Pipe hangers and supports.
5. Relief valves.
6. Back pressure regulating valves.
7. Strainers.
8. Flexible connectors.

B. Related Sections:

1. Section 230553 - Identification for HVAC Piping and Equipment: Product requirements for valve and pipe identification for placement by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
3. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
5. ASME B31.1 - Power Piping.
6. ASME B31.9 - Building Services Piping.
7. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
8. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B32 - Standard Specification for Solder Metal.

4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
6. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
7. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter.
8. ASTM D2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
9. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
10. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
11. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
12. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
13. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
14. ASTM D2996 - Standard Specification for Filament-Wound Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
15. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:

1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 85 - Cast Iron Globe and Angle Valves, Flanged and Threaded.
7. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
8. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

F. NACE International:

1. NACE RP-01-69 - Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
- G. National Electrical Manufacturers Association:
 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- H. National Fire Protection Association:
 1. NFPA 30 - Flammable and Combustible Liquids Code.
 2. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
- I. Underwriters Laboratories Inc.:
 1. UL 536 - Flexible Metallic Hose.
 2. UL 567 - Pipe Connectors for Flammable Liquids and Combustible Liquids and LP-Gas.
 3. UL 842 - Valves for Flammable Fluids.
 4. UL 913 - Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous Locations.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.1, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use ball valves for throttling, bypass, or manual flow control services.
- F. Use spring loaded check valves on discharge of pumps.
- G. Use 3/4 inch ball valves with cap for drains at low points of piping, bases of vertical risers, and at equipment.
- H. Flexible Connectors: Use at or near pumps where piping configuration does not absorb vibration.

1.04 SUBMITTALS

A. Shop Drawings:

1. Piping System: Indicate layout of each piping system to scale of $\frac{1}{4}''$ / 12". Indicate piping system routing showing pipe sizes, elevations, pipe lengths, fitting locations, valve locations, and joint locations.

B. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Valves: Submit manufacturer's catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturer's catalog information including load capacity.
4. Fuel Piping Specialties: Submit manufacturer's catalog information including capacity, rough-in requirements, and service sizes.

C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Submit written test results for piping system pressure test.

E. Manufacturer's Installation Instructions: Submit piping system and piping accessories data.

F. Manufacturer's Certificate:

1. Certify Products meet or exceed specified requirements.

G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves, piping system, and system components.

B. Project Record Documents: Record actual locations of piping mains [**with invert elevations**], valves, manholes, and leak detection and location system.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 31.

B. List and label flexible connectors and hoses in accordance with UL 536.

- C. Perform Work in accordance with ASME B31.1 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- D. Perform Work in accordance with authority having jurisdiction for welding hanger and support attachments to building structure.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Furnish five year manufacturer warranty for valves excluding packing.

PART 2 - PRODUCTS

2.01 FUEL OIL PIPING - ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M or ASME B36.10M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M wrought carbon steel and alloy steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.02 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with [soldered] [brazed joints].
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.03 BALL VALVES

A. Manufacturers:

1. Morrison Brothers.
2. Substitutions: Accepted Substitution.

B. 1/4 inch to 2 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port.

2.04 CHECK VALVES

A. Spring Loaded Check Valves:

1. Manufacturers:
 - a. Morrison Brothers.
 - b. Substitutions: Accepted Substitution.
2. 2 inches and Smaller: MSS SP 80, Class 150, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, threaded ends.

2.05 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 31, ASME B31.1, MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support for Pipe 3 inches and Smaller: Cast iron hook.
- F. Vertical Support: Steel riser clamp.

- G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.06 STRAINERS

- A. Manufacturers:
 - 1. Morrison Brothers.
 - 2. Substitutions: Accepted Substitution.
- B. 2 inch and Smaller: Y pattern, bronze body, threaded ends, Class 150, 1/32 inch stainless steel perforated screen.

2.07 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Flexicraft.
 - 2. Substitutions: Accepted Substitution.
- B. 2 inches and Smaller: Corrugated bronze inner hose with single layer of Type 304 stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 200 psig.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.1 and MSS SP 89.

- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.04 INSTALLATION - ABOVEGROUND PIPING

- A. Install fuel oil piping in accordance with NFPA 31.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals. Install in accordance with NACE RP-01-69.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Epoxy paint all exposed piping.
- I. Install identification on piping systems including underground piping. Refer to Section 230553.
- J. Install valves with stems upright or horizontal, not inverted.
- K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

3.05 FIELD QUALITY CONTROL

- A. Pressure test fuel oil piping in accordance with NFPA 31.

3.06 SCHEDULES

A. Steel Pipe Hanger Spacing:

1. Pipe Size 1/2 Inch
 - a. Maximum Hanger Spacing: 7 feet
 - b. Hanger Rod Diameter: 3/8 inch
2. Pipe Size 3/4 Inch
 - a. Maximum Hanger Spacing: 7 feet
 - b. Hanger Rod Diameter: 3/8 inch
3. Pipe Size 1 Inch
 - a. Maximum Hanger Spacing: 7 feet
 - b. Hanger Rod Diameter: 3/8 inch
4. Pipe Size 1-1/4 Inch
 - a. Maximum Hanger Spacing: 7 feet
 - b. Hanger Rod Diameter: 3/8 inch
5. Pipe Size 1-1/2 Inch
 - a. Maximum Hanger Spacing: 9 feet
 - b. Hanger Rod Diameter: 3/8 inch
6. Pipe Size 2 Inch
 - a. Maximum Hanger Spacing: 10 feet
 - b. Hanger Rod Diameter: 3/8 inch
7. Pipe Size 2-1/2 Inch
 - a. Maximum Hanger Spacing: 11 feet
 - b. Hanger Rod Diameter: 1/2 inch
8. Pipe Size 3 Inch
 - a. Maximum Hanger Spacing: 12 feet
 - b. Hanger Rod Diameter: 1/2 inch

END OF SECTION

SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Refrigerant piping.
2. Pipe hangers and supports.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 495 - Refrigerant Liquid Receivers.
2. ARI 710 - Liquid-Line Driers.
3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:

1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

6. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
- E. American Welding Society:
 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. Underwriters Laboratories Inc.:
 1. UL 429 - Electrically Operated Valves.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide pipe hangers and supports in accordance with ASME B31.5.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- B. Product Data:
 1. Piping: Submit data on pipe materials, fittings, and accessories.
- C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Test Reports: Indicate results of refrigerant leak test.
- E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.05 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of piping, equipment and refrigerant accessories.
- B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 REFRIGERANT PIPING

- A. Copper Tubing to 7/8 inch OD: ASTM B88, Type K, annealed.
 - 1. Fittings: ASME B16.26 cast copper, compression type.
 - 2. Joints: Flared.

2.02 PIPE HANGERS AND SUPPORTS

- A. Conform to ASME B31.5.
- B. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.
- C. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.02 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.5.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- G. Provide copper plated hangers and supports for copper piping.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.03 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors.

- E. Install pipe identification in accordance with Section 230553.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide access where valves and fittings are not exposed.
- H. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- I. Install refrigerant piping in accordance with ASME B31.5.

3.04 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.
- B. Repair leaks.
- C. Retest until no leaks are detected.

3.05 SCHEDULES

- A. Copper Tube Hanger Spacing:
 - 1. Pipe Size 1/2 Inch:
 - a. Maximum Hanger Spacing: 5 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
 - 2. Pipe Size 3/4 Inch:
 - a. Maximum Hanger Spacing: 5 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
 - 3. Pipe Size 1 Inch:
 - a. Maximum Hanger Spacing: 6 feet.
 - b. Hanger Rod Diameter: 3/8 inch.

END OF SECTION

SECTION 233400

HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Upblast centrifugal roof fans.

B. Related Sections:

1. Section 230513 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.

1.02 REFERENCES

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:

1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Refrigeration Institute:

1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.

D. ASTM International:

1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

E. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. Underwriters Laboratories Inc.:

1. UL 705 - Power Ventilators.

1.03 PERFORMANCE REQUIREMENTS

A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.

1.04 SUBMITTALS

A. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

B. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit fan manufacturer instructions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.06 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

D. Balance Quality: Conform to AMCA 204.

1.07 QUALIFICATIONS

1.08 Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

1.09 Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Furnish five-year manufacturer's warranty for fans.

1.13 EXTRA MATERIALS

- A. Furnish two sets of belts for each fan.

PART 2 - PRODUCTS

2.01 UPBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers:
 - 1. Aerovent; www.aerovent.com
 - 2. Hartzell Fan, Inc.; www.hartzellairmovement.com
 - 3. Substitutions: Accepted Substitution.
- B. Fan Unit: Upblast type. V-belt drive, FRP housing; resilient mounted motor; epoxy-coated galvanized wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Totally enclosed, fan cooled.

- E. Roof Curb: 12 inch high prefabricated FRP construction, built-in cant strips, and factory installed nailer strip.
- F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 4X enclosure.
- G. Performance & Characteristics: Refer to Exhaust Fan Schedule on Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.02 INSTALLATION

- A. Install fans according to manufacturer's instructions.
- B. Secure roof fans with stainless steel lag screws to roof curb.
- C. Install safety screen where inlet or outlet is exposed.
- D. Provide sheaves required for final air balance.

3.03 DEMONSTRATION

- A. Demonstrate fan operation and maintenance procedures.

3.04 PROTECTION OF FINISHED WORK

- A. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 233700

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Louvers.

1.02 ACTION SUBMITTALS

- A. Product Data: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
- B. Schedule of Outlets and Inlets: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.03 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.

PART 2 - PRODUCTS

2.01 WALL/DUCT SUPPLY REGISTERS/GRILLES

A. Manufacturers:

1. Nailor Industries Inc.
2. Price Industries Inc.
3. Titus; brand of JCI plc.
4. Substitutions: Accepted Substitution.

- B. Description: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch minimum spacing with spring or other device to set blades, front blades parallel to short dimension, double deflection.

- C. Details: Refer to schedule on Drawings.

2.02 WALL/DUCT EXHAUST AND RETURN REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Nailor Industries Inc.
 - 2. Price Industries Inc.
 - 3. Titus; brand of JCI plc.
 - 4. Substitutions: Accepted Substitution.
- B. Description: Fixed, streamlined blades parallel to long edge, ¾ inch minimum depth, ¾ inch maximum spacing, with blades set at 45 degrees.
- C. Details: Refer to schedule on Drawings.

2.03 LOUVERS, CHEMICAL RESISTANT

- A. Manufacturers:
 - 1. Hartzell Air Movement.
 - 2. M.K. Plastics Corporation.
 - 3. Porroff.
 - 4. Ruskin; Air Distribution Technologies, Inc.
 - 5. Substitutions: Accepted Substitution.
- B. Description: Fiberglass, stationary louver with horizontal, drainable blades.
- C. Details: Refer to schedule on Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install air outlets and inlets level and plumb, unless otherwise noted on the Drawings.
- B. Install roof mounted air outlets and inlets with sufficient clearance for cleaning and maintenance as noted by the unit manufacturer.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

- D. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.03 ADJUSTING

- A. After installation, adjust air outlets and inlets to air patterns indicated on the Drawings, or as directed by EOR, before starting balancing. Ensure all damper actuators operate smoothly and make corrections as required.

END OF SECTION

SECTION 238119

SELF-CONTAINED AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Self contained air conditioners with integral air cooled condensers.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

B. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

A. Product Data: Submit data indicating:

1. Cooling capacities.
2. Dimensions.

3. Rough-in connections and connection requirements.
4. Duct connections.
5. Electrical requirements with electrical characteristics and connection requirements.
6. Controls.
7. Accessories.

- B. Test Reports: Submit results of factory test at time of unit shipment.
- C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Manufacturer's Field Reports: Submit start-up report for each unit.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of controls separate from units.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.05 QUALITY ASSURANCE

- A. Cooling capacity: Rate in accordance with ARI 340/360.
- B. Sound Rating: Measure in accordance with ARI 270.
- C. Insulation and adhesives: Conform to requirements of NFPA 90A.
- D. Performance Requirements: Conform to minimum EER prescribed by ASHRAE 90.1 when tested in accordance with ARI 340/360.
- E. Outside Air Damper Leakage: Test in accordance with AMCA 500.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept equipment on site in factory packaging. Inspect for damage.

- B. Protect equipment from damage by providing temporary covers until construction is complete in adjacent space.

1.08 COORDINATION

- A. Coordinate wall openings and electrical rough-in locations to accommodate Work of this Section.

1.09 WARRANTY

- A. Furnish five-year manufacturer's warranty for compressors.

1.10 EXTRA MATERIALS

- A. Furnish one set of filters for each unit.

PART 2 - PRODUCTS

2.01 SELF CONTAINED AIR CONDITIONERS

- A. Manufacturers:
 - 1. Bard Manufacturing Company.
 - 2. Substitutions: Accepted Substitution.
- B. Product Description: Packaged, self-contained, through-the-wall air cooled terminal air conditioning unit, with wall sleeves, electric refrigeration system, and remote temperature controls.
- C. Cabinet:
 - 1. Frame and Panels: Galvanized steel with baked enamel finish, removable access doors or panels. Manufacturer's standard color.
- D. Supply Fan:
 - 1. Fan: Direct-drive, backward curved centrifugal fan, statically and dynamically balanced, resiliently mounted.
 - 2. Fan motor: Electrically commutated motor (ECM) with speed control.
- E. Compressor:
 - 1. Hermetically sealed, resiliently mounted with positive lubrication and internal motor overload protection.

- F. Evaporator Coil: Direct expansion type constructed of copper tubes expanded onto aluminum fins.
- G. Integral Air Cooled Condenser:
 - 1. Fan: Direct-drive, statically and dynamically balanced, with permanently lubricated bearings.
- H. Controls:
 - 1. Safety Controls: Factory wired and installed in each unit.
 - 2. DDC Controls: Remote mounted controller by unit manufacturer capable of the sequences on the Drawings and following:
 - a. Temperature control.
 - b. Control and monitoring of multiple units.
 - c. Dry contacts for interconnect with station SCADA system.
- I. Supply and Return Openings: Field mounted constructed of galvanized steel. Furnish grilles by unit manufacturer.
- J. Corrosion resistant coating: Furnish manufacturer's standard coating on the following unit components:
 - 1. Condenser coil.
 - 2. Exposed refrigerant piping.

2.02 Condensate Piping

- A. Pipe Material: PVC or CPVC, schedule 40.
- B. Fittings: Match pipe material. Solvent weld joints.
- C. Finish: UV resistant paint, safety yellow to match existing piping. Painting not required for underground piping.

2.03 SOURCE QUALITY CONTROL

- A. Perform factory test of each unit. Test includes:
 - 1. Dynamic trim balance of completed fan assembly.
 - 2. Complete run check of electrical components and safety controls, including proper control sequencing.
 - 3. Pressure test, at rated pressure, of refrigerant coils and condenser coils prior to unit assembly.
 - 4. Leak check of completed refrigerant circuits.

5. Compressor run check.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify wall is ready for installation and openings are the correct size and in the proper location.
- B. Verify electrical rough-in is at correct location.

3.02 INSTALLATION

- A. Install unit according to manufacturer's instructions. Furnish wall curb adapter by unit manufacturer.
- B. Install accessories furnished loose for field mounting.
- C. Install electrical devices furnished loose for field mounting.
- D. Install control wiring between unit control panel and field mounted control devices.

3.03 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units.
- B. Vacuum clean coils and inside of cabinets.
- C. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.
- D. Install new throwaway filters in units after Substantial Completion.

3.04 DEMONSTRATION

- A. Demonstrate unit operation and maintenance.

3.05 PROTECTION OF FINISHED WORK

- A. Protect finished surfaces of cabinets with protective covers during remainder of construction.

END OF SECTION

SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air handling unit (Light Commercial up to 5 Tons).
2. Condensing unit (Light Commercial up to 5 Tons).

B. Related Sections:

1. Section 232300 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

- A. Product Data: Submit data indicating:
 - 1. Cooling and heating capacities.
 - 2. Dimensions.
 - 3. Weights.
 - 4. Rough-in connections and connection requirements.
 - 5. Duct connections.
 - 6. Electrical requirements with electrical characteristics and connection requirements.
 - 7. Controls.
 - 8. Accessories.
- B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- D. Manufacturer's Field Reports: Submit start-up report for each unit.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of controls installed remotely from units.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.05 QUALITY ASSURANCE

- A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.
- B. Cooling Capacity: Rate in accordance with ARI 210/240.
- C. Sound Rating: Measure in accordance with ARI 270.
- D. Insulation and adhesives: Meet requirements of NFPA 90A.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.08 COORDINATION

- A. Coordinate installation of condensing units with building structure.
- B. Coordinate installation of air handling units with building structure.

1.09 WARRANTY

- A. Furnish five-year manufacturer's warranty for compressors.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONING UNITS

- A. Manufacturers:
 - 1. Daikin.
 - 2. Mitsubishi.
 - 3. Substitutions: Accepted Substitution.
- B. Product Description: Split system consisting of air handling unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressors, refrigeration circuits, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.02 AIR HANDLING UNIT (LIGHT COMMERCIAL UP TO 5 TONS)

- A. Configuration: As indicated on Drawings.
- B. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor complying with NEMA MG1, Type 1. Motor permanently lubricated with built-in thermal overload protection.

- C. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Factory leak tested under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides.
- D. Refrigeration System: Single refrigeration circuits controlled by factory installed thermal expansion valve.

2.03 CONDENSING UNIT (LIGHT COMMERCIAL UP TO 5 TONS)

- A. General: Factory assembled and tested air-cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.
- B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.
- C. Compressor: Scroll type compressors, resiliently mounted, with internal motor overload protection.
- D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum fins, factory leak and pressure tested.
- E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.
- F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.
- G. Corrosion Protection: Provide factory or shop applied corrosion protection coating rated for 1,000 hours per ASTM B117. Coating shall be applied to coil and piping within the unit.

2.04 CONTROLS

- A. Thermostat: Programmable electronic space thermostat with automatic changeover. Furnish system selector switch off-heat-auto-cool and fan control switch, auto-on.

2.05 Condensate Piping

- A. Pipe Material: PVC or CPVC, schedule 40.
- B. Fittings: Match pipe material. Solvent weld joints.
- C. Finish: UV resistant paint, safety yellow to match existing piping. Painting not required for underground piping.

- D. Provide brass threaded bard fitting to transition from indoor air handling unit condensate drain tubing to condensate piping.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify wall is ready for condensing unit support bracket.

3.02 INSTALLATION - AIR HANDLING UNIT

- A. Install indoor air handing units according to manufacturer's instructions.
- B. Install components furnished loose for field mounting.

3.03 INSTALLATION - CONDENSING UNIT

- A. Install outdoor condensing units according to manufacturer's instructions.
- B. Install refrigerant piping from unit to condensing unit.
- C. Evacuate refrigerant piping and install initial charge of refrigerant.
- D. Install electrical devices furnished loose for field mounting.
- E. Install control wiring between air handling unit, condensing unit, and field installed accessories.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.05 CLEANING

- A. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.06 DEMONSTRATION

- A. Demonstrate air handling unit operation and maintenance.

- B. Demonstrate starting, maintenance, and operation of condensing unit including low ambient temperature operation.

3.07 PROTECTION OF FINISHED WORK

- A. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 260510

GENERAL EQUIPMENT STIPULATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. These General Equipment Stipulations apply, in general, to all equipment provided under other Specification Sections. They shall supplement the detailed equipment specifications, but in cases of conflict the equipment specifications shall govern.
- B. Related Sections: Electric and DC-driven motors are specified in Section 262200.

1.02 OPERATION AND MAINTENANCE

- A. All equipment suppliers shall submit to Engineer, through Contractor, 4 bound copies and 1 electronic/digital format copy of a manual containing specifications, Drawings, and descriptions of equipment; installation instructions; operation, maintenance, and lubrication manuals; parts lists; emergency instructions; and where applicable, test data with curves, wiring diagrams, PLC programs on CD and schematics. This information shall be submitted for each item of equipment furnished under this Contract and shall be specific to the exact equipment models complete with all appurtenances provided. It shall also include detailed, comprehensive directions for all required maintenance activities and for the repair or replacement of all wearing parts. Special attention shall be paid to necessary safety precautions that Owner's staff should take when operating, maintaining, or repairing the equipment.
 - 1. Bound copies of O&M Manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after Engineer has given final approval of Shop Drawings. All manuals shall be submitted to Engineer following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by Engineer. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.
 - 2. Electronic Copy of O&M Manuals: Each equipment O&M manual shall be provided with an electronic disk, matching the content of the final approved printed O&M Manual. The information shall be saved in a single ".pdf" file, with bookmarks for each chapter, section, appendices, etc., as well as each piece of equipment. Where numerous pieces of equipment may be addressed within a section, a second tier of bookmarks shall be provided to allow quick access to each piece of equipment or key piece of information.

3. "Sample" Table of Contents:

Bookmarks

Table of Contents

Section 1 - Approved Shop Drawings

Submersible Pumps

Base-mounted Pumps

Section 2 - Installation Instructions and Parts Identification

Submersible Pumps

Base-mounted Pumps

Section 3 - Operations and Maintenance Information

Section 4 - Troubleshooting (If not included in Section 3.)

Section 5 - Parts List (If not included in Section 3.)

Section 6 - Lubrication Instructions (If not included in Section 3.)

4. These manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after Engineer has given final approval of Shop Drawings. All manuals shall be submitted to Engineer following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by Engineer. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.

1.03 QUALITY ASSURANCE

- A. Compliance with OSHA: All equipment provided under this Contract shall meet all the requirements of the Federal and/or State Occupational Safety and Health Acts. Each equipment supplier shall submit to Engineer certification that the equipment furnished is in compliance with OSHA.
- B. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by Contractor.

1.04 SHIPPING AND HANDLING EQUIPMENT

- A. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment and handling.

1.05 SPARE MATERIALS

- A. All V-belt driven equipment shall be furnished with a complete set of spare belts per each piece of equipment. When two or more similar pieces of equipment are furnished, replacement belt assemblies shall be furnished for every other drive assembly.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

2.02 MATERIALS

- A. Anchor Bolts: Anchor bolts, nuts, and washers shall be hot-dipped galvanized in conformity with ASTM A 385 and be supplied with sleeves.
- B. Shop Painting:
 - 1. Non-submerged Applications: Tnemec Series 37H, Chem-Prime.
 - 2. Submerged, Non-potable Applications: Tnemec Series 66, Hi-Build Epoxoline.
 - 3. Submerged, Potable Applications: Tnemec Series 139, Pota-Pox II.
 - 4. Rust preventive compound shall be:
 - a. Dearborn Chemical, No-Ox-ID2W.
 - b. Houghton, Rust Veto 344.
 - c. Rust-Oleum R-9.

2.03 MANUFACTURED UNITS

- A. Wall and Slab Sleeves and Castings: Where water- or gas-tightness is essential and at other locations where indicated, wall castings and sleeves shall be provided with an intermediate flange located approximately at the center of the wall or slab.
 - 1. All sleeves and casting shall be flush with walls and underside of slabs but shall extend 2 inches above finished floors.

2.04 COMPONENTS

- A. Lubrication: Equipment shall be adequately lubricated by systems which require attention no more often than weekly during continuous operation. Lubrication system shall not require attention during start-up or shutdown and shall not waste lubricants.

1. Lubrication point shall be easily accessible with all points of application provided with standard fittings for greasing or placing oil.
 2. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity for all consumption prior to completion of required testing and acceptance of equipment by Owner.
- B. Safety Guards: All belt or chain drives, fan blades, couplings, vertical or horizontal drive shafts, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 gauge or heavier galvanized or aluminum-clad sheet steel or 1/2-inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal and painted safety yellow.
1. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be hot-dipped galvanized.
 2. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.
- C. Anchor Bolts: All necessary anchor bolts shall be provided as per the manufacturer's recommendations for size, strength, and location and shall meet the requirements of Standard Details on Drawings. Substantial templates and working drawings for installation shall be provided. Two nuts shall be furnished.
1. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.
- D. Seals: Mercury seals will not be acceptable.
- E. Bearings: All antifriction bearings shall be designed per the Anti-Friction Bearing Manufacturers Association (AFBMA) recommendations with a rating life of B-10, 30,000 hours.
- F. Equipment Bases: A cast iron or welded steel baseplate shall be provided for all equipment and motor assemblies. Each baseplate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have a threaded drain connection. Bases shall be fully braced to withstand shock loads and resist buckling. Necessary safety guard mounting shall be provided as part of the equipment base.

2.05 FABRICATION

- A. Shop Painting: All iron and steel surfaces shall be protected by suitable paint or coatings applied in the shop or at point of fabrication. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment.

1. All iron and steel surfaces which will be totally or partially submerged or located in a continuously or intermittently moist atmosphere during normal operation shall be shop blast cleaned to a near-white finish, removing all dirt, rust-scale, and foreign matter by

any of the recommended methods outlined in the Steel Structures Painting Council Specification SP-10.

2. The cleaned surfaces shall be shop primed before any rust bloom forms. All other exposed surface shall be properly filed, scraped, sanded, etched, brushed, sandblasted, and/or cleaned to provide surfaces free from dirt, loose crystals, rust, scale, oil, and grease and shop primed.
 3. Shop primed surfaces shall be painted with one or more coats of a primer which meets the requirements of this Section and is compatible with the finish painting system specified in Section 09 90 00. Minimum shop coat thickness shall be 1.5 dry mills.
- B. Electric motors, speed reducers, starters, pumps, motor control centers, control panels, and other self-contained or enclosed components shall be shop finished with 2 coats of an enamel paint as per manufacturer's recommendations.
 - C. Where specified, steel and iron surfaces shall be hot-dipped galvanized in conformity with ASTM A 153 and A 385.
 - D. Machined, polished, and nonferrous surfaces which are not to be painted or galvanized shall be coated with rust preventive compound.

PART 3 - EXECUTION

3.01 EQUIPMENT BASES

- A. The baseplate shall be installed on a concrete base. Baseplates shall be anchored to the concrete base with suitable anchor bolts and grouted in place.

3.02 WALL AND SLAB SLEEVES AND CASTINGS

- A. Unless otherwise shown on Drawings or specified, at all points where pipes or conduit pass through walls, slabs or roofs, suitable sleeves or castings shall be furnished and installed. Sleeves and castings shall not be painted in areas to be embedded in the concrete. All loose rust, scale, grease, or oil shall be removed prior to pouring the concrete.
- B. Unless otherwise shown or approved by Engineer, the space between the pipe and the sleeve shall be caulked. All ground buried and water or gas retaining wall or slab sleeves or castings shall be caulked with lead and oakum or be mechanical joint.

3.03 EQUIPMENT INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment shall visit Site of Work a minimum of 2 times, once prior to installation to review installation procedures with Contractor and once after installation to inspect, check, adjust if necessary, and approve the equipment's installation. The equipment

supplier's representative shall revisit Site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to Engineer.

- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Each equipment supplier's representative shall furnish to Owner, through Engineer, a written report certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by connecting piping or anchor bolts;
 - 4. Has been operated under full load condition and that it operated satisfactorily to Engineer;
 - 5. That Owner's Representative has been instructed in the proper maintenance and operation of the equipment; and
 - 6. Furnish Owner a copy of all test data recorded during the installation check including noise level and vibration readings.

3.04 OPERATION AND MAINTENANCE TRAINING

- A. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.
 - 1. Manufacturer's representative shall provide 1 day, 8 hours, on-site training.
 - 2. Review operating and maintenance data contained in the operating and maintenance manuals.
 - 3. Schedule training with Owner, provide at least 7-day prior written notice to Engineer.

END OF SECTION

SECTION 260511

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 26.
- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. Contractor shall fully coordinate electrical Work with other trades to avoid interferences.
 - 3. In the event of interferences, Contractor shall request clarification from Engineer in writing.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 013323, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
 - 1. Submit product data covering the items included under this Section of Work.
- B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to Engineer on tracing cloth, mylar, or sepia paper from which blueprints can be obtained.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 260510, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with requirements in Section 017700. In addition, Contractor shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.
- B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor, motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

1.04 QUALITY ASSURANCE

- A. National Electrical Code: Comply with NFPA 70, National Electrical Code.
- B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

- A. Contractor shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold Owner harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
 1. Upon completion of Work, Contractor shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to Owner. Contractor shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

- A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
 - 1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).
- B. Provide stainless steel electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.
- C. Coordinate with power company high voltage and/or low voltage metering requirements. Furnish, install, and connect metering equipment not furnished, installed or connected by power company.
- D. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- E. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- F. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.
- G. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to Engineer.
- I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.

- J. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- K. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 RACEWAY INSTALLATION

- A. Outdoors, use the following materials:
 - 1. Exposed Conduit: Rigid aluminum conduit and fittings.
 - 2. Underground Direct Buried Conduit: PVC schedule 40 conduit.
 - 3. Underground Concrete Encased Conduit: PVC schedule 40 conduit.
 - 4. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.
- B. Indoors, use the following wiring materials:
 - 1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
 - 2. Conduit shall be concealed within walls and below slab. Conduit shall not run on drywall walls.
 - 3. Exposed Conduit: Aluminum conduit.
 - a. Exceptions:
 - 1) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid steel conduit.
 - 4. Concealed Conduit: Aluminum conduit.
- C. Minimum size conduit shall be 1 inch unless shown otherwise.
- D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit.
- E. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum

by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.

- F. Install expansion fittings in all exposed rigid nonmetallic conduit runs of 20 feet or more.
- G. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.
- H. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.
- I. Concealed Raceways: Raceways embedded in slabs shall be installed in the middle third of the slab thickness where practical and leave at least 1-inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run 1-inch and smaller raceways with a minimum of bends in the shortest practical distance. Run larger conduit parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit used, raceways must be converted to PVC externally coated rigid metal conduit before rising above floor.
- J. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- K. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.
- L. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.
- M. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.

- N. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.
- O. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- P. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- Q. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits enter or leave hazardous locations.
 - 2. Where conduits enter or leave NEMA 4X areas.
 - 3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
 - 4. Where required by the NEC.
- R. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- S. Install device boxes at the height above the floor as follows for:
 - 1. Light switches, 4 feet.
 - 2. Receptacles, 18 inches except in NEMA 4 and 4X areas, 4 feet.
 - 3. Thermostats, 4'-0".
- T. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.
- U. Position recessed outlet boxes accurately to allow for surface finish thickness.

- V. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.
- W. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.
- X. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- Y. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.
- Z. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.
- AA. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- BB. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

- A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.
- B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.
- C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.

- D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.
- E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.
 - 1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.
- F. Seal wire and cable ends until ready to splice or terminate.

3.04 EQUIPMENT CHECKOUT AND TESTING

- A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.
- B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:
 - $R_{min.} = 4 (KV + 1)$ at 25 degrees C winding temp.
 - $R_{min.} = IV + 1$ at 40 degrees C winding temp.
 - 1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.
 - 2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.
- C. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
 - 1. Vacuum interior of cubicles and remove foreign material.
 - 2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
 - 3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or Engineer.
 - 4. Fill motor bearings requiring oil.
 - 5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.

6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
8. Check exposed bolted power connections for tightness.
9. Check operation of breakers, contactors, etc., and control and safety interlocks.
10. Check tightness of bolted structural connections.
11. Check leveling and alignment of enclosures.
12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

SECTION 260513

WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Low-Voltage Wire and Cable.
 - 2. Instrument Cable.
 - 3. Multiconductor Control Cable.
 - 4. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.
- B. Reports of field tests prepared as noted in Section 260510.

1.03 QUALITY ASSURANCE

- A. UL Compliance: Provide components which are listed and labeled by UL. For cables intended for use in air handling space comply with applicable requirements of UL Standard 710, "Test Method for Fire and Smoke characteristics of cables used in Air Handling Spaces."
- B. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.
- C. Network Wiring Experience: Contractor must be able to prove to the satisfaction of Owner that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- D. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or

some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.

- E. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.
- F. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Low-Voltage Wire and Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. The Okonite Co.
 - d. Southwire Co.
 - 2. Connectors for Low-Voltage Wires and Cable Conductors:
 - a. AMP.
 - b. O-Z/Gedney Co.
 - c. Square D Company.
 - d. 3M Company.
 - 3. Instrument Cable:
 - a. Belden (Trade Nos. 1120A and 1118A).
 - 4. Local Area Network Cable:
 - a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

- A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless

multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable.

- B. Conductor Material: Copper. Minimum size power wire shall be No. 12 AWG.
- C. Insulation: Provide THWN/THHN insulation for single- and 3-phase circuits.
 - 1. Provide THHN/THWN, insulation for grounding conductors installed in raceways.
 - 2. Provide THHN/THWN insulation for control conductors.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

- A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 INSTRUMENT CABLE

- A. Instrument Cable: 600-volt minimum insulated shielded cable with two or more twisted No. 16 AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding. Cable routed in conduit underground shall be wet location rated.

2.05 MULTICONDUCTOR CONTROL CABLE

- A. Multiconductor Control Cable: Concentrically cabled No. 14 AWG stranded copper conductors with saturated interstitial fillers; overall binder of nylon or similar material; and PVC jacket. Quantity of conductors shall be as indicated on Drawings. Provide Type 2010 individual conductor insulation unless otherwise indicated on Drawings as one of the following:
 - 1. Type ISS: 15 mils polyethylene with 5 mils nylon.
 - 2. Type 2010: 20 mils polyethylene with 10 mils PVC.
 - 3. Type 3015: 30 mils polyethylene with 15 mils PVC.

2.06 LOCAL AREA NETWORK CABLE

- A. Category 6 (Ethernet) Data and Patch Cable:
 - 1. Paired, 4-pair, 24 AWG, solid bare copper conductors with polyethylene insulation, overall aluminum foil-polyester tape shield with 24 AWG stranded tinned copper drain wire, 100 percent shield coverage, PVC jacket.
 - 2. UL verified to Category 6.
 - 3. Provide plenum rated cable where installed exposed.

4. Cable routed in conduit underground shall be wet location rated.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to Engineer. Test reports shall include ambient temperature and humidity at time of testing. Notify Engineer 48 hours prior to test with schedule.
- B. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by Contractor with at least 5 years of experience in testing Network cabling systems.
 1. TESTING: Contractor shall test each network cable segment. **Owner reserves the right to have representation present during all or a portion of the testing process. Contractor must notify Owner 5 days prior to commencement of testing.** If Owner elects to be present during testing, test results will only be acceptable when conducted in the presence of Owner.
 2. DOCUMENTATION (Network Cable): Contractor shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
 - b. All required documentation shall be submitted within 30 days at conclusion of the project to Owner.
 - c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
 3. ACCEPTANCE: Acceptance of the Data Communications System, by Owner, shall be based on the results of testing, functionality, and receipt of documentation.
- C. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to Engineer.

END OF SECTION

SECTION 260526

GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical grounding and bonding Work as follows:
 - 1. Solidly grounded.
- B. Applications of electrical grounding and bonding Work in this Section:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Metal building frames.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.

2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

A. Materials and Components:

1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.
2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
3. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 20 feet.
4. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. Connect grounding conductors to underground grounding electrodes using exothermic weld process or mechanical compression type connectors.
- B. Ground electrical service system neutral at service entrance equipment to grounding electrodes.
- C. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.
- D. Connect system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

- E. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.
- F. Connect grounding electrode conductors to 1-inch diameter or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.
- G. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 2/0 AWG bare copper grounding cable.
- H. Bond bare No. 2/0 AWG grounding cable in duct banks to grounding cable in vaults and to power equipment ground bus at ends of each duct bank.
- I. Bond strut and other metal inside of electrical manholes and vaults to bare No. 2/0 AWG grounding cable carried in duct bank.
- J. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.
- K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- L. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.
- M. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.
- N. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.
- O. Uninsulated conductors shall be bare copper in accordance with ASTM B3.
- P. Use tinned-coated in corrosive environments including when buried in earth or embedded in concrete.

END OF SECTION

SECTION 260529

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.

- h. Unistrut Diversified Products.
- 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney.
 - i. Producto Electric Corp.
 - j. Racco, Inc.
 - k. Red Seal Electric Corp.
 - l. Spring City Electrical Mfg. Co.
 - m. Thomas & Betts Corp.

2.02 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors or indoor wet conditions, in NEMA 4 areas, or embedded in concrete shall be stainless steel.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners. Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: Steel springhead type.
 - 3. Hanger Rods: 0.375-inch diameter minimum, steel.

- C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable iron casting with hot-dip galvanized finish.
- E. Stainless Steel U-Channel Systems: 12 gauge or 0.105-inch-thick steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

- A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gauge.
 - b. 4-inch to 6-inch: 16-gauge.
 - c. Over 6-inch: 14-gauge.
 - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 260533

RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Raceways for electrical wiring. Types of raceways in this Section include the following:
 - 1. Liquidtight flexible conduit.
 - 2. Rigid aluminum conduit.
 - 3. Rigid nonmetallic conduit.
 - 4. PVC externally coated rigid metal conduit.
 - 5. Conduit bodies.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for the following products:
 - a. Conduit.
 - b. Conduit bodies.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 - 2. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in Work include:

1. Conduit:

- a. Allied Tube.
- b. Carlon.
- c. Johns Mansville.
- d. Occidental Coatings.
- e. Orangeburg.
- f. Perma-Cote Industries.
- g. Republic Steel.
- h. Robroy Industries.
- i. Steelduct Co.
- j. Triangle Conduit.
- k. Wheatland Tube.
- l. Youngstown Sheet and Tube.

2. Liquidtight Conduit:

- a. Anamet, Inc.
- b. Carlon.
- c. Electric-Flex.
- d. Thomas and Betts.

3. Conduit Bodies:

- a. Adalet-PLM.
- b. American Electric.
- c. Appleton Electric Co.
- d. Carlon.
- e. Crouse-Hinds Division, Cooper Industries, Inc.
- f. Delta Industrial Products.
- g. Killark Electric Mfg. Co.
- h. Kraloy Products Co.
- i. O-Z/Gedney Co.
- j. Perma-Cote Industries.
- k. Robroy Industries.
- l. Spring City Electrical Mfg. Co.

4. Conduit Thread Paint:

- a. CRC Chemicals, USA.
- b. Sherwin Williams.

- c. ZRC Chemical Products Co.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Aluminum Conduit: ANSI C 80.1.
- B. PVC Externally Coated Rigid Metal Conduit and Fittings: ANSI C 80.1 and NEMA RN 1., Type 40, 40 mil nominal coating and thickness. The bond of the PVC to the substrate shall be stronger than the tensile strength of the PVC.
- C. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

2.03 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.04 CONDUIT BODIES

- A. Provide matching gasketed covers secured with corrosion-resistant screws. Use cast covers in NEMA 4 areas and stamped steel covers in NEMA 1 and 12 areas. Use nonmetallic covers in NEMA 4X areas and threaded, ground joint covers in NEMA 7 and NEMA 9 areas.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies as follows:
 - 1. Rigid Aluminum Conduit: Use aluminum conduit bodies and threaded hubs.
 - 2. PVC Externally Coated Rigid Metal Conduit: Use hot-dipped galvanized or cadmium-plated cast or malleable iron conduit bodies with threaded hubs factory PVC-coated. Field application of PVC coating to conduit bodies is not acceptable. Secure covers using PVC encapsulated or stainless steel screws.
 - 3. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 260535

CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:
 - 1. Outlet and device boxes.
 - 2. Pull and junction boxes.
 - 3. Bushings.
 - 4. Locknuts.
 - 5. Conduit hubs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop-fabricated, (nonstock items). For shop-fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.
 - 2. Product data for boxes, fittings, cabinets, and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
 - 2. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Outlet Boxes, Concealed Conduit System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Bell Electric, Square D Company
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co.
 2. Outlet Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type JB, GS, or SHE.
 - b. Crouse Hinds, Type GS or GRF.
 3. Device Boxes, Concealed Conduit Systems:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric; Emerson Electric Co.
 - c. Bell Electric, Square D Company.
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co
 4. Device Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse Hinds, Type FS/FD.
 5. Junction and Pull Boxes, Concealed System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Bell Electric, Square D Company.
 - e. GTE Corporation.

- f. Keystone Columbia, Inc.
 - g. OZ/Gedney Co.; General Signal Co.
 - h. Spring City Electrical Mfg. Co.
- 6. Junction and Pull Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse Hinds, Type FS/FD.
- 7. Bushings, Knockout Closures, Locknuts, and Connectors:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. AMP, Inc.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Appleton Electric Co., Emerson Electric Co.
 - e. Bell Electric; Square D Co.
 - f. Midland-Ross Corp.
 - g. Midwest Electric, Cooper Industries, Inc.
 - h. OZ/Gedney Co., General Signal Co.
 - i. RACO Div., Harvey Hubbell, Inc.
 - j. Thomas & Betts Co., Inc.

2.02 CABINETS, BOXES, AND FITTINGS - GENERAL

A. Outlet Boxes: Suitable for the conduit system installation as follows:

- 1. Exposed Conduit: Provide cast or malleable iron, zinc, electroplated outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 4 areas and stamped steel covers for NEMA 12 and undesignated areas.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide the appropriate explosion-proof rating for outlet boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes where PVC-coated conduit is specified.
- 2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide cast metal outlet boxes for exterior outlets.

B. Device Boxes: Suitable for the conduit system as follows:

- 1. Exposed Conduit: Provide cast device boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs on device boxes.

- a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide appropriate explosion-proof rating for device boxes installed in NEMA 7 and NEMA

9 areas. Provide factory PVC-coated device boxes where PVC-coated conduit is specified.

2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Provide cast metal device boxes for exterior devices.

C. Junction and Pull Boxes: Suitable for the conduit system installation as follows:

1. Exposed Conduit: For pull and junction boxes 50 cubic inches and smaller, provide cast or malleable iron, zinc electroplated boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs and cast covers with neoprene gaskets. For pull and junction boxes larger than 50 cubic inches provide watertight sheet metal boxes. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. Provide code-gauge sheet steel construction for boxes smaller than 1,000 cubic inches. Provide 0.10-inch steel construction, hot-dip galvanized after fabrication for boxes larger than 1,000 cubic inches. Secure box covers using No. 8 or larger machine screws spaced at intervals not exceeding 6 inches. Provide a continuous neoprene or rubber gasket cemented to the box cover where it contacts the box body.
 - a. Exceptions: Provide stainless steel junction boxes in NEMA 4 and 4X areas. Provide appropriate explosion-proof construction for boxes located in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes for areas where PVC conduit is used.
2. Concealed Conduit: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.

- D. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications. Provide watertight hubs on conduits terminated at sheet steel enclosures in NEMA 4 areas.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 260553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
 - 1. Buried electrical line warnings.
 - 2. Identification labeling for cables and conductors.
 - 3. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- B. Underground Line Marking Tape: Permanent, bright colored, continuous printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.

- D. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.
- E. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.
- F. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- G. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.
- H. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- I. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.
- B. Underground Electrical Line Identification: During trench backfilling for exterior nonconcrete encased underground power, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench, do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct buried and in raceway.
- D. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system following OWNER's method of phase identification or as follows:

<u>Phase</u>	<u>480/277 Volts</u>
A	Yellow
B	Brown
C	Orange
Neutral	White
Ground	Green

1. 208 Volt, 3-Phase Power:

- a. Black.
- b. Red.
- c. Blue.

2. 240/120 Volt, 1-Phase Power:

- a. Black.
- b. Red.
- c. White Neutral.

3. Motor Leads, Control Cabinet/MCC:

- a. Black, numbered L1-T1, etc.

4. Control Wiring:

- a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
- b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
- c. Blue DC.
- d. Green Ground.

E. Use conductors with color factory applied entire length of conductors except as follows:

- 1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

- b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- F. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.
- G. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

SECTION 260573

SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.02 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - a. Short-circuit study input data, including completed computer program input data sheets.
 - b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - 1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - 2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
 - 1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- F. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Comply with IEEE 399 and IEEE 551.
 - 1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory" features as listed in IEEE 399.
- B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.02 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6. Derating factors and environmental conditions.
 - 7. Any revisions to electrical equipment required by the study.
- D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstands ratings exceed available short-circuit current at equipment installation locations.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data:
 - 1. One-line diagram of system being studied.
 - 2. Power sources available.
 - 3. Manufacturer, model, and interrupting rating of protective devices.

4. Conductors.
 5. Transformer data.
- G. Short-Circuit Study Output Reports:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.

- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.01 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
- B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 01 78 39 "Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

3.02 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- I. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION

SECTION 260574

COORDINATION STUDIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.02 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
 - a. Coordination-study input data, including completed computer program input data sheets.
 - b. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power System Analysis Software Developer.
2. For Power Systems Analysis Specialist.
3. For Field Adjusting Agency.

- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
 - 1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Comply with IEEE 242 and IEEE 399.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report

device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.02 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6. Any revisions to electrical equipment required by the study.
 - 7. Study Input Data: As described in "Power System Data" Article.
 - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73 "Short-Circuit Studies."
- D. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, and ground).

- 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - e. Ground-fault protective devices.
 - f. The largest feeder circuit breaker in each motor-control center and panelboard.
 5. Maintain selectivity for tripping currents caused by overloads.
 6. Provide adequate time margins between device characteristics such that selective operation is achieved.
 7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA

- B. Obtain all data necessary for conduct of the overcurrent protective device study.
 - 1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
- C. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

3.03 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection per manufacturer's written instructions and to IEEE 242.
- K. Include the ac fault-current decay from induction motors and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Include in the report identification of any protective device applied outside its capacity.

3.04 MOTOR-STARTING STUDY

- A. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and, and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.05 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.06 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:
1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
 2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 260575

ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.02 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
 - 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Comply with IEEE 1584 and NFPA 70E.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.

2.02 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260574 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.03 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Electrical Identification" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.

6. Available incident energy.
 7. Working distance.
 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.02 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573 "Short-Circuit Studies."
 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260574 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current per IEEE 1584 recommendations.
 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current per NFPA 70E recommendations.
 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

- E. Include low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.03 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.

3.04 LABELING

- A. Apply arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 - 1. Motor-control center.
 - 2. Low-voltage switchboard.
 - 3. Switchgear.

4. Medium-voltage switch.
 5. Medium voltage transformers
 6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
 7. Panelboard and safety switch over 250 V.
 8. Applicable panelboard and safety switch under 250 V.
 9. Control panel.
- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
1. Indicate arc-flash energy.
 2. Indicate protection level required.

3.05 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.06 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION

SECTION 262200

MOTORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section applies, in general, to all electric or DC motor-driven equipment provided under Divisions 2 through 46 Sections. This Section shall supplement the detailed Equipment Specifications, but in cases of conflict, the Specifications indicated in this Section shall govern.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submittals for motors shall accompany the specific equipment the motor is to be supplied with.
 - 2. Submit product literature for each motor.
- B. Operation and Maintenance Manuals: Prior to start up, submit operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment, and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label, shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by Contractor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, motors shall be standard design and construction. Manufacturers offering products which may be incorporated in Work include:

1. Motors:

- a. General Electric
- b. Reliance Electric Co.
- c. U.S. Electric Motors.

- B. For motors that are integrally constructed as a piece of equipment, such as appliances, hand tools, etc., and where manufacturer would be required to redesign equipment to meet these general specifications, it is the intent to allow such standard motors to be used, provided they do not exceed 1-1/2 horsepower and are suitable for use on standard power systems.

2.02 MATERIALS

- A. Shop primers shall be Tnemec "77 Chem-Prime," or equal.
- B. Rust preventive compound shall be equal to Dearborn Chemical "No-Ox-ID2W," Houghton "Rust Veto 344," or Rust-Oleum "R-9".

2.03 MANUFACTURED UNITS

- A. Electrical Motors: Motor design and application shall comply with current ANSI, IEEE, NEMA, and AFBMA standards and with the NEC where applicable. They shall be squirrel cage induction motors rated 60 hertz, continuous duty for use in 40 degrees C ambient temperature. Motors shall comply with NEMA MG1, Part 31, Definite Purpose Inverter-Fed Motors whether used with variable frequency drives or not.
 - 1. The motors shall be sized within their rated loads under the specified conditions without utilizing the service factor. Motor sizing measured at the motor output shaft shall include all loadings on the motor. Motor loadings shall include the maximum or specified load condition of the driven equipment plus all drive losses of components, located between the motor and the driven equipment.
 - 2. The motor winding temperature rise shall be NEMA Standard for the class of insulation used at the rated service factor load.
- B. Motors 50 horsepower and larger shall have embedded passive temperature switches in the windings for use in the motor control circuit that will limit the winding temperature as defined by NEMA Standard MG1-12.53 Type 1. The contact shall be normally closed and rated to operate a 120 volt AC control relay (40 VA).
- C. All integral horsepower motors shall have oversize conduit boxes with clamp-type grounding terminals inside which are effectively connected to all noncurrent-carrying motor parts.
- D. Unless these general specifications are supplanted by the detailed equipment specifications, motors shall be rated and constructed as follows:

1. Below 1/2 Horsepower: Motors shall be rated 115/230 volts, single phase, but shall be suitable for use on 208 volt power system. They shall have permanently lubricated sealed bearings (antifriction type where high radial or axial thrusts are produced by the driven equipment). Standard motors shall be totally enclosed fan cooled, totally enclosed air-over, or totally enclosed nonventilated capacitor start type as shown on Equipment Schedule(s) or specified in the equipment specifications. Totally enclosed explosion-proof motors shall be provided where required per equipment specifications section.
 2. From 1/2 to 1-1/2 Horsepower: Motors shall be rated 115/230 volts single phase or shall be rated 230/460 volts 3-phase as indicated by Equipment Schedule(s). In either case they shall be suitable for use on 208 volt power systems under their given load conditions. They shall have bearings as in 2.03 F.1. The standard enclosures shall be totally enclosed fan cooled, totally enclosed nonventilated, totally enclosed explosion-proof, or open drip-proof as shown on Equipment Schedule(s) or specified in the equipment specifications.
 3. From 2 to 300 Horsepower: Motors shall be rated 230/460 or 460 volt, 3-phase. They shall be grease lubricated, ball bearing, Class B insulated, minimum or as specified. Horizontal motors shall be WPI, open drip-proof, totally enclosed fan-cooled or totally enclosed explosion-proof (NEC, Class I, Group D) as shown on Equipment Schedule(s) or specified in the equipment specifications. Vertical motors shall meet NEMA standard WPI, open drip-proof, or totally enclosed fan cooled or totally enclosed explosion-proof as shown on Equipment Schedule(s) or specified in the equipment specifications.
- E. Horizontal and vertical motors may also be weather protected, Type I, and shall have encapsulated or sealed windings.
- F. Open drip-proof type motors shall have encapsulated or sealed windings when called for on Drawings or Equipment Schedules.
- G. Special duty and severe environment application shall have motors which are designed specifically to meet the special conditions as specified.
- H. All three phase motors shall be provided with a 1.15 service factor.
- I. Motors connected to variable frequency drives shall be inverter duty rated.
- J. Insulation:
1. All motors shall have Class B insulation with temperature rise by resistance at full load rating of a Class B insulation in accordance with NEMA Standards for Motors and Generators, NEMA MG1, and based on a maximum ambient temperature of 40 degrees C unless otherwise specified.
 2. Insulation systems shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies and mechanical or thermal shock for 480 volt motors. Provide 80 degrees C, Class B rise or better by resistance at 100 percent load and provide a Class

F insulation system, suitable for an ambient temperature motor operation of 0 to 40 degrees C at no more than 3,300 feet (1,000 m) above sea level for inverter duty motors. This temperature rise shall be met when motors are operated and controlled with the VFD(s). The motor insulation system shall have full capability to handle the common mode voltage conditions imposed by the VFD.

3. Motors for outdoor service shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.
4. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. Class H varnish shall be used.

K. Enclosures:

1. Motors shall have a steel or cast iron frame and a cast iron or stamped steel conduit box, as specified below. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material. A frame mounted pad with drilled and tapped hole, not less than 1/4-inch (6 mm) diameter, shall be provided inside the conduit box for motor frame grounding.
 - a. Totally enclosed fan cooled: TEFC motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 40 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and upgraded insulation by additional dips and bakes to increase moisture resistance.

L. The following symbols will be employed on Equipment Schedule(s) to indicate the required motor enclosure and construction features:

1. TE Totally Enclosed, may be nonventilated, fan-cooled or air-over type.
2. TENV Totally Enclosed Nonventilated.
3. TEFC Totally Enclosed Fan-cooled.
4. TEEP Totally Enclosed Explosion-proof, Class I, Div. I, Group D.
5. ODP Open Drip-proof.
6. WPI Weather Protected Type I.
7. E/S Encapsulated or Sealed Windings.
 - a. All motors with encapsulation or sealed windings shall have a water-tight conduit box.

- M. See NEMA Standard MG1 for definition of above terms.
- N. Motor Efficiency: Where Equipment Schedule(s) indicate that motors shall be designed for high efficiency, they shall meet or exceed the Motor Operating Characteristics shown on High Efficiency Motor Schedule No. 16220.2, appended to this Section. Guaranteed minimum efficiency at full load shall be based on IEEE Standard 112, Test Method B. Nominal motor efficiencies are average expected values. Manufacturer's motor Shop Drawings shall indicate full compliance with the High Efficiency Motor Schedule No. 16220.2.

2.04 FABRICATION

- A. Electric motors shall be shop-finished with 2 coats of enamel paint per manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION (NOT USED)

3.02 FIELD QUALITY CONTROL

- A. Inspect all terminations for proper connection.
- B. Check motor for proper rotation.

3.03 INSTALLATION CHECK

- A. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. Equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and equipment installation and operation is satisfactory to Engineer.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Inspection Report: A written report of the installation check shall be submitted to Engineer. The report shall certify that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by any connection or anchor bolts;
 - 4. Has been operated under full load condition and that it operated satisfactorily to Engineer; and

5. That Owner's representative has been instructed in the proper maintenance and operation of the equipment.
6. Furnish Owner a copy of all test data recorded during the installation check including noise level and vibration readings.

END OF SECTION

SECTION 262213

TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of transformers specified, and include the following:

1. Dry-type transformers (lighting transformers).

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product Data: Submit manufacturer's technical product data, including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data.
2. Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations.
3. Wiring Diagrams: Submit wiring diagrams for power distribution transformers.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. NEMA Compliance: Comply with NEMA Standard Pub/Nos. ST 20, "Dry-Type Transformers for General Applications," TR 1, and TR 27.
2. UL Compliance: Comply with applicable portions of ANSI/UL 506, "Safety Standard for Specialty Transformers. Provide power/distribution transformers and components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Acme Electric Corporation.

2. Cutler-Hammer.
3. General Electric Company.
4. Hevi-Duty Electric Div., General Signal Corp.
5. Square D Company.

2.02 POWER/DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Dry-Type Distribution Transformers (75 kVA or less): Provide factory assembled, general purpose, air cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated. Three-phase, 60 hertz, 10 kV BIL, 4.0 percent impedance with 480-volts delta connection primary and 208/120 volts secondary wye connected. Provide primary winding with 4 taps; 2 to 2-1/2 percent increments above and below full-rated voltage for de-energized tap-changing operation. Insulate with Class 150 or 220-degree C insulation and rate for continuous operation at kVA, and limit transformer temperature rise to maximum of 115 or 150 degrees C, respectively. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure.
- C. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Power distribution panelboards.
 - 2. Lighting panelboards.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.
 - 2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
 - 3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Cutler-Hammer Products.
 - 2. Siemens, Inc.

3. Square D Company.

2.02 PANELBOARDS

- A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with tin-plated aluminum, or silver- or tin-plated copper bus bars braced for 65,000 rms symmetrical amperes fault current, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide as indicated, either molded-case bolt-on main and branch circuit breakers for each circuit with toggle handles that indicate when tripped. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards.
 - a. Power Monitor: Microprocessor-based device capable of measuring each phase current, line-to-line voltage, line-to-neutral voltage, watts, VARS, power factor, demand watts, and frequency. Unit shall contain kilowatt hour totalizer. 3-CT's and 3 (fused)-PT's shall be provided, and factory installed as required. Unit shall have two Form C, 2-amp rated output contacts, one to alarm upon abnormal voltage level and one to alarm on power failure.
- C. Lighting Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar with bolt-in type heavy-duty, quick-make quick-break, single pole circuit breakers, and toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Panelboards and circuit breakers shall be braced for 10,000 rms symmetrical amperes fault current unless otherwise indicated.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit directory frame and card with clear

plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

- E. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.
- F. Ground Fault Protected Breakers: Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles. For breakers dedicated to equipment (sump pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.
- G. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.
- H. Spares: In each panelboard provide 8 installed, single pole, 20A spare circuit breakers unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

- A. Type out panelboard's circuit directory card upon completion of installation Work.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:

1. Receptacles.
2. Ground fault circuit interrupter receptacles.
3. Snap switches.
4. Wall plates.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Bryant Electric Co., Division of Hubbell Corporation.
2. Cooper Wiring Devices.
3. Hubbell, Inc.
4. Leviton Manufacturing Co., Inc.

5. Pass and Seymour, Inc.

2.02 WIRING DEVICES

- A. Provide devices which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Provide ivory color devices and wall plates except as otherwise indicated.
- B. Receptacles: Provide specification grade or heavy-duty grounding receptacles with the NEMA rating shown on Wiring Device Schedule on Drawings. Comply with UL 498 and NEMA WD1.
- C. Ground Fault Interrupter (GFI) Receptacles: Provide specification grade or heavy-duty "feed-through" type ground fault circuit interrupter, with integral grounding type NEMA 5-20R duplex receptacles arranged to protect connected downstream receptacles on same circuit. Provide units rated Class A, Group 1, per UL Standard 94.3.
- D. Snap Switches: Provide quiet type specification grade or heavy-duty AC switches rated 20A at 120/277 volts AC. Provide single pole, 2-pole, 3-way or 4-way switches as indicated. Comply with UL 20 and NEMA WD1.

2.03 WIRING DEVICE ACCESSORIES

- A. Wall plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated. Exterior receptacle covers shall provide rainproof protection while in use. Conform to requirements of Section 260513. Provide plates possessing the following additional construction features:
 - 1. NEMA 12 and Unclassified Areas. Material and Finish: 0.04-inch-thick stainless steel, or 0.04-inch-thick brass, chrome plated.
 - 2. NEMA 4 Area Material and Finish: Cast screw cap and cover plate for receptacles. Cast cover plate with lever or plunger operator for switches.
 - 3. NEMA 4X Material and Finish: Non-metallic, watertight wall plates 0.05-inch-thick aluminum, anodized.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 26 28 11

CIRCUIT BREAKERS AND FUSIBLE SWITCHES – LOW VOLTAGE

PART 1 – GENERAL(NOT USED) PART

2 – PRODUCTS

2.01 MANUFACTURERS

- A. Provide Cutler Hammer or Square-D circuit breakers to match equipment provided. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions.

2.02 MOLDED CASE CIRCUIT BREAKERS – 800 A AND BELOW

- A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- D. Circuit breakers 400ampere frame and below shall be have thermal-magnetic trip units and inverse time-current characteristics.
- E. Circuit breakers 800ampere through 1200-ampere frame shall have microprocessor-based rms sensing trip units.

2.03 QUICK-MAKE/QUICK-BREAK FUSIBLE SWITCHES

- A. Protective devices shall be quick-make/quick-break fusible switches. Fusible switches 30 amperes through 600 amperes frames shall be furnished with rejection Class “R” or “J” type fuse clips unless otherwise scheduled. Fusible switches 800 amperes through 1200 amperes shall be furnished with Class L fuse clips. Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the ON position or prevent placing the switch in the ON position with the cover open. Provide defeater for authorized personnel. Handles shall have provisions for padlocking and shall clearly indicate the ON or OFF position. Front cover doors shall be padlockable in the closed position.

PART 3 – EXECUTION(NOT USED)

END OF SECTION

SECTION 262813

CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 017000, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley.
 - 2. Cutler-Hammer.
 - 3. Siemens, Inc.
 - 4. Square D Company.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Provide NEMA 4, 4X, 7, 9, or 12 enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD." Disconnect switches shall be provided with two normally open auxiliary contacts.

- B. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.
- C. Fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.

2.03 ACCESSORIES

- A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 - 1. Stainless Steel for NEMA 4 and 4X switches.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 262923

VARIABLE FREQUENCY DRIVE UNIT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete simplex type variable frequency drive (VFD) units and appurtenances including by-pass starters, drive reactors, DC chokes, harmonic filters, dV/dT filters, enclosures, and certain auxiliary items, as indicated and as specified, to provide a complete operating system.
- B. Variable frequency drive unit shall be furnished, installed and electrically connected by the electrical subcontractor unless otherwise indicated in process or mechanical specifications and plans for skid or packaged equipment.
- C. VFD units shall be manufacturer's standard technology and in production for a minimum of 2 years.
- D. VFD units shall communicate via Ethernet.
- E. Provide control system operation, input and control signals, status signals and devices in accordance with Division 40.
- F. Provide Underwriter's Laboratories listed drive components where applicable.
- G. Provide VFD 3% load reactor when cable length between VFD and motor is greater than 100 feet and less than 200 feet, and dv/dt filters when cable length is 50 feet or greater in length to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1, section 30.02.2.9.
- H. Each VFD unit to be provided is to exhibit less than 5% voltage total harmonic distortion and less than 3% voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 2.02A. This bus to be referred to as the point of common coupling (PCC). Provide 3%-line reactor on all 12 and 18 pulse VFD's and 5%-line reactor on all 6 pulse VFD's. Reactors may be reduced or eliminated if VFD vendor harmonic calculations show compliance with these specifications and IEEE 519 distortion limits.
- I. Contractor shall acquire the Collier County Public Utilities Division SCADA Standards, Section 1.3 Drives (Appendix A 1.3 Drives) and shall meet the Owner requirements in that standard.

1.02 RELATED WORK

- A. Division 1: General Requirements.

B. Sections 462140 and 462180.

1.03 REFERENCES

- A. Underwriter's Laboratories Inc. (U.L.):
 - 1. UL-508 Electrical Industrial Control Equipment.
- B. National Electrical Manufacturers Association (NEMA): MG 1.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA-70 National Electric Code.

1.04 SUBMITTALS

- A. Shop Drawings: Submit the following in accordance with Section 013323 – Shop Drawings:
 - 1. Shop Drawings: Provide a complete list of equipment components, and materials, including manufacturer's descriptive and technical literature, and catalog cuts. Provide complete wiring, system interconnection and schematic diagrams for the equipment and controls furnished including external interlocked and controlled components, equipment layout, time versus current curves for protective devices and any other details required to demonstrate that the system and the required external controls has been coordinated and will properly function as designed.
 - a. Provide data to verify that drives can be used for motor lead lengths up to 60 feet without output filters or VFD cable. Include information from the VFD manufacturer or output filter or cable manufacturer (if required) stating that the motor terminal voltage limitations as defined by NEMA Standard MG-1, section 31.40.4.2, are met. For VFD's located more than a cable length is greater than 100 feet and less than 200 feet, and dv/dt filters when cable length is 200 feet or greater in length to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1, section 30.02.2.9. Submit Harmonic Compliance Certificate based on theoretical calculations prior to raceway rough-ins for approval.
 - b. Each VFD unit to be provided is to exhibit less than 5% voltage total harmonic distortion and less than 3% voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 2.02A. This bus to be referred to as the point of common coupling (PCC). Provide 3% line reactor on all 12 and 18 pulse VFD's and 5% line reactor on all 6 pulse VFD's. Reactors may be reduce or eliminated if VFD vendor harmonic calculations show compliance with these specifications and IEEE 519 distortion limits.

- c. Provide enclosure drawings and details showing all dimensions and construction details.
- 2. Submit information relative to location and expertise of local service office and personnel.
- 3. For informational purposes only, provide installation and anchoring details to meet earthquake requirements as specified and indicated on structural drawings.
- 4. For informational purposes only, submit manufacturer's printed installation instructions.
- 5. Spare Parts Data: Submit a list of spare parts for the equipment specified.
- 6. Operating and Maintenance Instruction Manuals:
 - a. Furnish:
 - 1) Operating instruction manuals outlining step-by-step procedures required for system startup and operation.
 - 2) Manufacturer's name, model number, service manual parts list.
 - 3) Brief description of equipment and basic operating features.
 - 4) Maintenance instruction manuals outlining maintenance procedures.
 - 5) Troubleshooting guide listing possible breakdown and repairs.
 - 6) Point-to-point connection wiring diagram for the system.
 - 7) 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.

1.05 QUALITY ASSURANCE

- A. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Coordinate all design information with the Electrical Contractor. Review the proper installation of each type of VFD unit with the equipment supplier prior to installation.
 - 1. Services of Service Engineer, specifically trained on type of equipment specified. Man-day requirements listed exclusive of travel time.
 - a. Assist in location of devices, methods of mounting, field erection, etc.: 1 man-day.

- b. Start-up and testing: 3 man-days.
- c. At the end of start-up service provide for a maximum of six members of the owners staff at the facility site to receive training from the startup/testing service Engineer: 1 man-day.
- d. Service-inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls: 2 man-days.
- e. Man-day is defined as one 8-hour day, excluding travel time.

1.06 DELIVERY, STORAGE AND HANDLING

A. Shipping:

- 1. Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.
- 2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
- 3. Deliver spare parts after installation but as specified before start-up of drives. Deliver to Owner after completion of work.

B. Storage:

- 1. Inspect and inventory items upon delivery to site.
- 2. Store and safeguard equipment, material and spare parts.

1.07 WARRANTY AND SERVICE:

- A. Provide in accordance with Section 017833 and as specified.
- B. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 24 months and, in this time period, include onsite, parts and labor warranty. All labor to be performed by local factory trained service engineers. Warranty shall commence upon substantial completion.
- C. Ensure that equipment manufacturer has local branch office staff with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.
- D. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer shall have at least five years commercial experience in the manufacture, operation and servicing of equipment of type, size, quality, performance, and reliability equal to that specified.
- B. Variable Frequency Drive Units:
 - 1. Allen-Bradly Power Flex 753 (1.0 to 350 HP)
 - 2. Allen-Bradly Power Flex 755 (400 to 500 HP)
- C. VFD Input Filters and Output Filters/Reactors:
 - 1. Trans-Coil, Inc.
 - 2. MTE Corporation.
 - 3. Power Quality International.
 - 4. Or acceptable equivalent product.

2.02 PROVISIONS

- A. Service Conditions:
 - 1. Ambient Temperature Range: 0 deg. C to 40 deg. C.
 - 2. Operational Humidity: Up to 90 percent non-condensing.
 - 3. Environment: Enclosure NEMA 12.
 - 4. Altitude: Below 3,300 ft. above sea level.
 - 5. Input Power:
 - a. Nominal voltage - 460 volts (plus 10 percent or minus 10 percent), 3-phase, 3 wire.
 - b. Nominal Frequency - 60 Hertz (plus or minus 2 Hz.).
 - c. Service provided from feeder breaker on distribution bus.

B. Drive System: 0-500 HP Units

1. General:

- a. Furnish solid state variable frequency, microprocessor type with Pulse Width Modulated (PWM) output wave form converter. The VFD shall employ a full wave rectifier to prevent input line notching, a DC bus choke, DC bus capacitors and Insulated Gate Bipolar Transistors (IGBT) as the output switching device to convert nominal 480 volts, 3 phase, 60 Hertz, 3 wire input power into adjustable-frequency 3 wire system at 0 to 480 volts, 3 phase, 0 to 60 Hertz output power. Provide output speed control of required motor under variable torque load or constant torque as required by the driven equipment.
- b. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard two-wire "start-stop" and the Contractor shall furnish wiring accordingly.
- c. Variable frequency drive manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining loads, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.
- d. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.
- e. Provide flux vector control type drives, also known as field-oriented control, with hard-wired motor speed feedback encoder or tachometer, for full torque at zero speed capability.
- f. Provide VFD control which ensures accurate zero to full load torque control at low frequencies, including zero speed, with torque repeatability accuracy of 2% or better and torque response time less than 20 ms.
- g. Provide on drive, a disconnecting device and fixed diode input rectifier (for a constant power factor).
- h. For units rated greater than 50 Hp, provide VFD with the following type three phase PWM rectifier section: 18-pulse.

- 1) The design shall be optimized for harmonic rich and high neutral current environment.
- i. All components of the drive shall be designed and sized for the abnormal condition of continuous operation of the driven equipment specified herein at loads up to 15% above rated full load.
- j. RMS harmonic output of the drive not to provide more than 5 percent increase in motor heating over similar operation of the motor with zero harmonics in the current.
- k. The unit shall withstand drive output terminal line-to-line and line-to-ground short circuits without component failure during start-up and during operation. Drive to safely shutdown until short is cleared.
- l. NEMA 1 type cabinet for each drive unit.
- m. For inverter rated squirrel cage motors, per NEMA Standard MG-1, part 31.40.4.2, the following limit values at the motor terminals are to be observed:
 - 1) For motors with base rating voltage less than or equal to 600 volts, the peak instantaneous voltage must be limited to 1600 volts or less, with a voltage rise time greater than or equal to 0.1 micro-seconds.
- n. The VFD manufacturer shall guarantee that the above voltage limits will be met with the motor installed up to 100 cable feet from the VFD drive unit. If the VFD manufacturer is not able to guarantee that the above voltage limits will be met, provide a drive output filter or reactor, appropriately rated, located within the VFD enclosure and near the VFD output terminals, which shall ensure that the limitations listed above are maintained. A device located at the motor terminals is not acceptable.
- o. The drive unit shall be of modular design to provide for ease and speed of maintenance.
- p. Control circuits shall be isolated from power circuits. Unit to accept a 4-20 mA DC speed control signal from an isolated, ungrounded transmitter with unit in remote mode and from local door-mounted manual speed potentiometer or micro-processor type keypad with unit in local mode. The input 4-20 mA signal to be optically isolated from the drive run control circuit. Manual speed potentiometer or keypad controls to have adjustable minimum speed setting of 10 to 80% of full speed and maximum speed setting of 50 to 100% of full speed. The total speed setting to follow a linear time ramp, adjustable from 1-300 seconds for acceleration and deceleration control.
- q. Provide trap filters for the drive unit to meet the requirements of the harmonic study under paragraph 2.02. Filters shall be provided with contractors and controlled by the VFD to remove them from the line when the drive is not

operating. Contractors shall be provided with spare contacts for remote alarm and to energize status lamp at VFD enclosure.

- r. VFD shall be capable of full rated output when powered by incoming voltage with Total Harmonic Distortion (THD) in excess of 10%.
- s. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.
- t. Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions. Provide NEMA enclosure type as specified on drawings. Provide integral fans or cooling systems as required by the application. Circuit breaker interlocks to be able to be bypassed via lever on front door surface. NEMA 1 type enclosures to have keypad controls located on exterior of enclosure. Provide visual alarm indicator on cabinet door.

2. Performance characteristics:

- a. Output amps: 110 percent of rated, continuous.
- b. Current limit: Range 0 to 130% for constant torque applications, 0 to 110% for variable torque applications, for 1 minute minimum.
- c. Acceleration time to top speed, 1-300 seconds, minimum, adjustable.
- d. Deceleration time from top speed, 1-300 seconds, minimum, adjustable.
- e. Frequency stability: +/- 0.5% (at 25 degrees C, +/-10 degrees C) after reaching operating temperature.
- f. Output voltage: Proportional to frequency with low speed boost.
- g. Combined drive/and filtering efficiency, defined as motor shaft KW divided by VFD input KW, shall meet the following minimum requirements at the specified operating points:
 - 1) 97 percent at 60 Hz VFD output and 100 percent load.
 - 2) 92 percent at 50 Hz VFD output and 60 percent load.
- h. VFD fundamental power factor shall be 0.98 or higher at all speeds and loads.
- i. The VFD shall be capable of sustaining continued operation with a 30% dip in nominal line voltage. Output speed may decline only if current limit rating of the VFD is exceeded.

- j. Losses to be utilized in drive system efficiency calculation shall include the input isolation transformer, harmonic filter and power factor correction if applicable. Auxiliary controls such as internal VFD control boards and cooling fans shall be included in all loss calculations.

3. Drive Protection:

a. General:

- 1) Fault detection and trip circuits shall protect VFD and connected motor against line voltage transients, single-phase, power line overvoltage and undervoltage, output overvoltage and overcurrent, and VFD overtemperature. The VFD shall employ three (3) current limit circuits to provide trip free operation. The slow current regulation limit circuit shall be adjustable to a minimum 125% of the VFD's variable torque current rating. The rapid current regulation limit shall be adjustable to a minimum 170% of the VFD's variable torque current rating. The current switch off limit shall be fixed at a minimum 225% of the VFD's variable torque current rating.

b. Internal Protection: Minimum circuitry as follows:

- 1) Current limiting, fast acting, semiconductor input fuses for protection of internal power semiconductors.
- 2) Instantaneous output overcurrent trip max. - 200 percent.
- 3) DC bus and control circuit transformer fusing.
- 4) Grounded control chassis.
- 5) Under and over voltage trip, 3 phases.
- 6) Motor overload protection, with solid state relays.
- 7) Fault reset push button.
- 8) Line to ground faults.
- 9) Input metal oxide varistor and input line reactor for transient protection.
- 10) VFD overtemperature.

c. Troubleshooting: Diagnostic aids to indicate cause of fault; used to assist in troubleshooting circuit problems. Isolated Form C contacts for remote indication of alarms to include the following:

- 1) Over/under voltage indication.

- 2) Overcurrent trip indication.
- 3) DC bus charged indication.
- 4) Fault detection indication.
- 5) Recycle start indication (to indicate that the unit tried to pick up load for three previous tries and failed).

- d. Provide power loss ride through capability which will allow the logic to maintain control due to load inertia without faulting.
- e. Provide a programmable automatic restart function which will provide a minimum with time delays between restarts of 3 restarts following a fault condition other than a ground fault, short circuit, internal fault, or user programmable fault condition. Restart type to be programmable for time delay or coasting motor restart.

C. Auxiliary Systems:

1. Provide variable frequency drive unit with appropriate power circuitry and auxiliary contacts for energizing and controlling the following devices associated with the motor, if required:
 - a. Space heaters.
 - b. Solenoid valves.
 - c. Remote indication of motor start and stop (isolated contacts).

D. Minimum Control Features:

1. Provide embedded digital and analog I/O.
2. LOCAL-REMOTE selection of Start/Stop control.
3. LOCAL/REMOTE selection of Speed Control.
4. Accept a grounded, isolated, 4-20 mA input remote speed control signal from an external device.
5. Provide a 4-20 mA output signal proportion to VFD output frequency for remote speed indication.
6. Provide auxiliary Ethernet/IP communication module
7. Provide Powerflex 750 Auxiliary Power Supply Module (20-750-APS)

E. Devices:

1. Provide operating, monitoring or alarm indicating devices, on keypad, with minimum as follows:
 - a. System control selector switch (RUN/OFF/REMOTE) (When in RUN position drive will run).
 - b. System speed control selector switch (LOCAL/REMOTE) (When in LOCAL position, speed controlled by manual speed potentiometer).
 - c. Keypad controls to set speed in manual mode.
 - d. Speed indicating meter in percent speed to indicate speed of the converter powered motor.
 - e. Run time meter.
 - f. Alarm and status lights.

2.03 SHOP TESTING (18 Pulse Units Only)

- A. Provide a factory performance test for each variable frequency drive unit. The test to consist of simulating the expected load to be driven. The drive to operate the actual motor load through the expected speed ranges. Test length to be a minimum of two hours.
- B. Provide a factory burn-in test for 24 hours minimum and a control and alarm test on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
- C. Provide typical prototype factory test data for short circuit testing of each type of drive supplied. Data to verify that each drive can be started into a line-to-line fault and line-to-ground fault on the drive terminals. Each drive can be operating at full load and be subjected to a line-to-line fault and line-to-ground fault on the drive terminals. All phases (A, B & C) to be included in test data.
- D. Provide certified documentation of all tests performed.
- E. Provide above stated tests in addition to routine factory tests.
- F. Owner to have option to witness all factory tests. Notify Owner two weeks before all tests.

2.04 SPARE PARTS:

- A. Provide in accordance with Section 01730 and as specified.

- B. Provide one spare board or card, three diodes, for each horsepower size drive. Spares will be color-coded or otherwise keyed to their original counterpart such that improper installation of spare cards is impossible. In addition to the cards, the manufacturer shall provide three spares for all expendable items such as pilot lamps, power fuses, and control fuses. Provide one keypad for every three VFD of the same model.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine VFD location for satisfactory preparation. Check conduits and raceway location for connection to units.
- B. Visually inspect delivered unit(s) and accessories for conformance with specification and drawings.
- C. Verify availability of appropriate pacing signal.
- D. Maintain variable frequency drive in upright position at all times.
- E. Protect variable frequency drive against damage. Store drive in clean, dry environment with temperature and humidity within range as specified by drive manufacturer. Energize space heaters during storage as recommended by manufacturer.

3.02 INSTALLATION

- A. Erect, install, and start-up equipment.
- B. The VFDs shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- C. Install VFDs to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.
- D. Factory-trained service personnel, other than sales representatives, shall supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested.

3.03 RUBBER MATS

- A. Three-foot-wide rubber mats shall be furnished and installed on the floor and in front of each VFD assembly. The mats shall be long enough to cover the full length of each VFD system. The mats shall be 1/2-inch-thick with beveled edges, canvas back, solid type with corrugations running the long way, and shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength.

The mats shall meet the requirements of ASTM D 178 for Type II, Class 4 insulating matting.

3.04 FIELD TESTING

- A. Provide in accordance with Section 017123.
- B. Perform testing checkout, and start-up for variable frequency drive equipment under technical direction of manufacturer's service engineer. Under no circumstances energize any portion of the drive system without authorization from manufacturer's technical representative.
- C. Field Tests:
 - 1. Test each drive over the total speed range that it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:
 - a. Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.
 - b. Output to the driven load in kilowatts.
 - c. For each drive, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the main distribution bus for maximum and minimum load conditions.
 - d. Measure the total harmonic voltage distortion and total harmonic current distortion at each PCC for maximum and minimum load conditions.
 - 2. Test each drive by using the actual control signal for remote and local operation.
 - 3. Test each driver's alarm functions.
 - 4. Perform all tests in the presence of the Owner's representative.
 - 5. Perform the above test in addition to the manufacturer's normal field tests.
 - 6. Submit final test report with summary comparing field test data with harmonic analysis design calculated values for each drive.

3.05 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017833.

END OF SECTION

SECTION 263213

STANDBY DIESEL GENERATOR SETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of (300 KW) 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, including batteries, instrument control panel, protective housing, day tanks, annunciator panel, exhaust silencer, wall thimble, and accessories.
- B. Types of generator sets required for the Project include:
 - 1. Permanent Diesel Engine-driven Generator.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, 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.
- 4) Fuel system day tank

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.

j. Warranty data.

k. 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.

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.
3. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG1, "Motors and Generators," and MG2, "Safety and Use of Electric Motors and Generators."
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. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section. Unit shall be provided with a full factory warranty of 2 years from date of Engineer's acceptance. Warranty shall commence upon substantial completion.

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:
 - a. Caterpillar.
 - b. Cummins.

2.02 GENERATOR

- 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. Generator set shall meet local air emission regulations.
- 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 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 battery charger with 5-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.
- 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 on Schedule with 35 percent maximum instantaneous voltage dip. 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. On indoor mounted units, radiator shall be equipped with a duct adapter flange. An air duct with flexible connecting sections shall be provided between radiator duct flange and exhaust damper.
- 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.
 3. Provide relays with 2 normally open and 2 normally closed contacts rated 5A at 120 volts AC and which are energized when unit is running, fault, and low fuel. Wire these contacts to terminal strips for remote use.
 4. Provide for remote use a 4-20mA signal output for continuous fuel tank level.
 5. 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.
 6. Mount instrument control panel on unit such that it is isolated from generator set vibration.

2.03 GENERATOR ACCESORIES

- A. Coolant Heater: Provide an engine coolant heater, of voltage indicated on Schedule, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements of NFPA 99.
- B. 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 duct shall be Schedule 10 steel pipe, minimum.
 - 1. Provide bellows sections, insulated wall thimbles, inlet and outlet flexible section as shown on Drawings. Design of exhaust silencer and stack including all ducting shown shall have a pressure drop not exceeding 5 inches of water.
 - 2. 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.
- C. 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 300 amp 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. Trip settings for all breakers shall be selected for the rating of the generator power circuit as indicated on Drawings or on Schedule.
 - 3. 2. 100% ratings under UL shall be required as noted on ENGINEER's drawings.
 - 4. AIC rating for generator power circuit breaker shall meet or exceed that of the upstream service entrance rating.
 - 5. Generator power circuit breaker shall be UL listed as short circuit, service entrance rated device under UL and NEC.
 - 6. Provide breaker and alternator trip curves in the submittal. Show coordination of curves for equipment provided.

- D. Provide protective relays to protect the generator system/alternator.
- E. 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.

2.04 ENGINE FUEL SYSTEM:

- A. Diesel fuel system shall consist of an engine-driven fuel supply pump, fuel filters, and a day tank and lift pump set.
- B. Fuel filters shall have elements which may be easily replaced without breaking any fuel line connection or disturbing fuel pumps or any other part of engine. Oil filters shall be conveniently located ahead of injection or circulating pump so that fuel is thoroughly filtered before it reaches injectors. Screens or filters requiring cleaning or replacement shall not be used in injection or circulating pump, or in injection valve assemblies.

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 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: engine heaters, battery charger, generator strip heater, and remote annunciator.
 - c. Check, during start-up test mode, for exhaust leaks, path of exhaust gases outside the building, 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. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
 - 1) Perform a 4-hour load bank test at a 1.0 PF at full nameplate rating. Loadbank, cables and other equipment required for this test to be supplied by the genset supplier. 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 35 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.

- e. Upon completion of installation, 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 Section 263213.13 COLLIER COUNTY STANDBY DIESEL GENERATORS TECHNICAL SPECIFICATIONS Page 17 of 17 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 26 36 00

AUTOMATIC TRANSFER SWITCHES

PART 1-GENERAL

1.01 GENERAL

- A. Automatic transfer switches shall be furnished as shown on plans, with full load current and voltage rating as shown, normal and emergency. The transfer switch shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure NEMA ICS 6 or 4X that is constructed in accordance with Underwriters' Laboratories, Inc., Standard UL-1008. Provide transfer switches by Cummins no equal. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing).
- B. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.
- C. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents. Contractor to verify available fault currents. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.
- D. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position. Transfer switches shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions. The transfer switch shall be configurable to control the operation time from source to source (program transition; delayed transition operation). Syncchecked two position transfer switches without delayed transition are not acceptable
- E. The transfer switch shall be capable of transferring successfully in either direction with 90% of rated voltage applied to the switch terminals. 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. Transfer switch shall be provided with copper long barrel Hi- Press lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

- F. 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 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. 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.
 2. "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. "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. "RESET/LAMP TEST" pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
 3. 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 the operator display panel.
 4. Analog AC meter display panel, to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor. The display shall be color-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.
- G. Engine starting contacts shall be provided in transfer switch to start the generating plant if any phase of the normal source drops below 85% of rated voltage, after an adjustable time delay period of 1-120 seconds. Provide loss of normal source circuit with phase sequence sensing capability that verifies phase angle relationship of source voltage.
- H. The transfer switch shall transfer to emergency as soon as the generator source voltage and frequency have reached 90% of rated. After restoration of normal power on all phases to 95% of rated voltage, adjustable time delay period of 2-25 minutes shall delay transfer to normal power until it has had time to stabilize. If the emergency power source should fail during the time delay period, the time delay shall be by-passed, and the switch shall return immediately to the normal source. Whenever the switch has retransferred to normal, the engine-generator shall be allowed to operate at no load for an adjustable period of time (10 minutes initially) to allow it to cool before shut-down. 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 voltage imbalance, loss of single phase, phase rotation, over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level), over or under frequency conditions.
 4. Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.
- I. The transfer switch shall include a test switch to simulate normal power failure with actual load transfer. A remote contact from the plant control system shall be accepted by the ATS to provide generator start and load control testing. Pilot lights shall be included on the cabinet door to indicate the main switch closed on normal (green) or emergency (Red); a yellow pilot light shall indicate the emergency power source running.
- J. The transfer switch shall include two auxiliary contacts on the main operating shaft indicating closed on normal and two auxiliary contacts indicating closed on emergency. In addition, two sets of relay contacts shall be provided to operate upon loss of the normal power supply. All relays, timers, control wiring and accessories to be front accessible. Auxiliary contacts shall be provided for remote plant control system monitoring.
- K. Include an exerciser with transfer switch for exercising generator in loaded condition every 168 hours for a period adjustable to 15 minute increments from 20 minutes minimum. Include automatic return to normal should the genset fail to provide load during the exercise run, if normal power is available. Provide programmed transition controls with adjustable time delay option to limit inductive load inrush currents. Switches without adjustable programmed transition are not acceptable.
- L. Provide for utility to genset ATS dry maintained contact input from the Pump Control Panel to start generator and transfer ATS on load. Provide a 20 light remote annunciator to be mounted adjacent to or within the front panel of ATS. I/O List from the ATS/Standby power system and standby system annunciator to the plant controls:
- Contact outputs from ATS:
- ATS/Genset not in Auto Utility
 - Supplying Load Generator
 - Supplying Load Utility Available
 - Generator Available ATS
 - Common Alarm
- Contact inputs to ATS:
- Remote Test
- M. The transfer switch shall be provided in a NEMA 12 (interior installation locations) or NEMA 4X stainless steel (exterior installation locations) wall mounted enclosure with a continuous hinge, gasketed and a 3 point latch. HMI deadfront

mounted through enclosure door shall be fitted with a hinged window kit, Schaefer's SPHWKSS-(###)-BC or approved equal.

1.02 SUBMITTALS

- A. Submit shop drawings and product data clearly indicating:
 - 1. Cabinet dimensions.
 - 2. All applicable options and accessories.
 - 3. Wiring diagrams.
 - 4. Interrupting or withstanding current rating.
 - 5. All electrical characteristics and data as required showing compliance with these specifications.
 - 6. Digital Metering device and wiring.

PART 2-PRODUCTS(NOT USED) PART 3-

EXECUTION

3.01 QUALITY ASSURANCE/TESTS

- A. As a precondition for approval, transfer switch, complete with timers relays and accessories shall be listed by Underwriters' Laboratories, Inc. in their Electrical Construction Materials Catalog under Standard UL-1008 (automatic transfer switches) and approved for use on emergency systems.
- B. When conducting temperature rise tests to paragraph 99 of UL-1008 the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
- C. Electrical Field Tests: Field testing shall be performed prior to substantial completion.
 - 1. Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
 - 2. Perform a contact resistance test across all main contacts.
 - 3. Verify settings and operation of control devices in accordance with the specifications provided by the manufacturer.
 - 4. Calibrate and test all relays and timers including voltage and frequency sensing relays, in phase monitor (synchronism check), engine start and cool- down timers, transfer and retransfer timers, etc.
 - 5. Perform automatic transfer tests: Simulate loss of normal power. Test Return to normal power. Simulate loss of emergency power. Simulate all forms of single phase conditions. Monitor and verify correct operation and timing of the following simulations: Normal voltage-sensing relays: Engine start sequence: Time delay upon transfer: Alternate voltage-sensing relays: Automatic transfer operation: Interlocks and limit switch function: Time delay and retransfer upon normal power restoration: Engine cool-down and shutdown feature.
 - 6. SYSTEM FUNCTION TESTS: Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
 - a. Develop test parameters for the purpose of evaluating performance

of all integral components and their functioning as a complete unit within design requirements.

- b. Test all interlock devices.
- c. Record the operation of alarms and indicating devices.

3.02 SHOP DRAWINGS

- A. Submit Shop Drawings and product data clearly indicating:
 - 1. Cabinet dimensions.
 - 2. All applicable options and accessories.
 - 3. Wiring diagrams.
 - 4. Interrupting or withstanding current rating.
 - 5. All electrical characteristics and data as required showing compliance with these specifications.
 - 6. Digital Metering device and wiring.

END OF SECTION

SECTION 26 36 13

SAFETY SWITCHES AND DISCONNECTS

PART 1 – GENERAL (NOT USED) PART 2 –

PRODUCTS

2.01 GENERAL

- A. All single throw disconnect switches and double throw manual transfer switches shall be heavy-duty horsepower rated type. Safety switches shall be rated for the available fault current where installed. Provide enclosed molded case switch type disconnects where required to meet high available fault current areas (above 10kaic). Switches shall be fusible only where required to meet equipment nameplate requirements.
- B. Switches shall be 240 volt rated on systems up to and including 120/208V and 600V rated on higher voltage systems. All switches for motors shall be horsepower rated. All switches shall be NEMA 4X stainless steel enclosure except switches mounted in air-conditioned spaces. As an alternate to NEMA 4X stainless steel enclosures provide polyglass enclosures for 30amp (10hp) switches in the chemical areas equal to Hubbell Circuit-Lock.
- C. Provide and install lugs on disconnect switch as required to accept conductors called for on drawings.
- D. Provide Switches with an externally operated handle; quick make quick break mechanism; the handle shall be interlocked with the switch cover by means of a defeatable interlock device. The switch shall be lockable in the "off" position with a padlock. Switches shall have arch suppressors, pin hinges and be horsepower rated at 600 volts.
- E. Double throw non-fused safety switches may be used for manual power transfer where shown on the drawings and in areas up to 10,000A available short circuit current. In areas above 10k amps use double throw molded case manual transfer switches rated for the available fault currents.

2.02 SUBMITTALS

- A. Submit product data on all major types of disconnects.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All three phase motors shall be provided with field mounted disconnects if they are not mounted within site of the three phase feeder breaker or control device they are

wired from.

- B. With the safety switch in the open position, both the motor heater and power circuits shall be open as well.

END OF SECTION

SECTION 264113

LIGHTNING PROTECTION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish labor and materials and items of service required for the completion of a functional and unobtrusive system of grounds, conductors and air terminals for protection against damage by lightning of designated structures as approved by the Engineer. Complete installation shall conform in respects to the current requirements of L.P.I. certified system program and legal, labor, insurance or other authorities having jurisdiction. The installing Contractor shall have a minimum of five (5) years experience in this specialized work and be a certified master installer of the Lightning Protection Institute. Materials used shall be furnished and recommended for their intended use by a reputable lightning protection manufacturer who is a Manufacturer Member of the Lightning Protection Institute. Materials shall be provided by Thompson Lightning Protection or an equal. Installer shall be Bonded Lightning Protection System, Inc., Jupiter, Florida or equal.
- B. As a minimum, the following structures and or buildings shall be provided with lightning protection systems.
 - 1. Electrical Buildings.
 - 2. Administration Building.
 - 3. Other structures.

1.02 SUBMITTALS

- A. Submittals for Approval
 - 1. Refer to Contract General Conditions and Section 013323, Shop Drawings for additional instructions on submittals and substitutions. Where conflicts occur between the General Conditions and this Section, the more stringent requirements shall apply.
 - 2. Shop drawings and manufacturer's data sheets are required for materials.
 - 3. Provide scaled plan and elevation views of structures for which lightning protection shall be provided. These plans shall show the proposed location of air terminals, typical air terminals, size and location for ground rods, cable, connectors and proposed methods of bonding. Bond to power service ground systems.

1.03 WARRANTY

- A. The Contractor shall warranty equipment for a period of one (1) year. Warranty shall commence upon substantial completion.

PART 2 - PRODUCTS

2.01 TERMINALS

- A. Provide terminals as per material vendor shop drawings. Terminal materials shall be as follows, bronze saddle and pressure plate, nickel tip highly polished, pure copper point. Provide mounting type and cable connections as required.

2.02 CABLE AND ACCESSORIES

- A. Provide stranded copper cable per material vendor. Provide braces, saddle, fittings and connectors as required compatible with materials.

2.03 GROUND RODS

- A. Provide copper clad ground rods, 3/4" x 20' minimum. Provide bronze compression clamps as required.

PART 3 -EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Locate terminals per vendor shop drawings. Points shall be a minimum of 2" of outside building edges, corners, and ridge ends. Maximum spacing shall be 20'. Maximum protection above object to be protected shall be 10".
- B. Maintain horizontal and downward coursing of main conductor and insure that bends have at least an 8" radius and do not exceed 90 degrees.
- C. Support exposed roof, downleads and bonding cables at 3' intervals.
- D. Ground electrodes shall be installed per Vendor shop drawings but install at least 1' below final grade.
- E. Interconnect Lightning Protection ground to electric and other building ground systems per codes.
- F. System shall be installed per Vendor shop drawings to insure proper code compliance and system certification. Any variance shall entail resubmittal and re-approval and costs shall be paid by the Contractor.

- G. As built drawings shall be provided and submitted by the Material Vendor in accordance with certification procedures.
- H. Materials shall be U.L. approved with "A" labels on conductors at 10' intervals and "B" labels on air terminals.
- I. Complete installation shall bear U.L. Master Label "C" to be secured by the system installer per U.L. 96A.
- J. Installation shall comply in all respects L.P.I. Code 175. Installation shall be made by or under the supervision of an L.P.I. Certified Master Installer. The completed installation shall receive system certification including submittal of forms L.P.I. CI-01, 02, and 03.
- K. Restoration to existing conditions. Contractor is responsible for restoring all areas which are disturbed by electrical work to original conditions.

END OF SECTION

SECTION 264313

SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Surge Protection Devices (SPD) for use on 120/208 volt and 480 volt, alternating current systems, and motor switchgear mounted applications.

1.02 REFERENCES

- A. Underwriters Laboratories Inc. (UL):
 - 1. 1449 - High Performance Suppression System.
 - 2. 1283 - High Frequency Extended Range Power Filter.
- B. American National Standards Institute (ANSI):
 - 1. C62.41-91 - Category C3 (Service Entrance).
 - 2. C62.45-91 - Category C Surge.

1.03 SUBMITTALS

- A. Shop Drawings: Include component layout and wiring terminations.
- B. Product data.
- C. Manufacturer's installation instructions.
- D. Operating and maintenance data.
- E. Warranties.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of transient voltage surge suppressor systems for minimum 5 years with satisfactory performance record.
- B. Regulatory Requirements: UL rating of Surge Protection Device shall meet or exceed UL rating of panelboard, motor control center, or other equipment in which SPD is installed. UL rating of equipment in which suppressor is installed shall not be affected by suppressor.

1.05 SEQUENCING AND SCHEDULING

- A. Coordinate with and furnish suppressors to switchgear manufacturer prior to shipment of equipment to site.

1.06 WARRANTY

- A. Warrant to correct defective products for minimum 5 years in accordance with manufacturer's standard warranty. Warranty shall commence upon substantial completion.

PART 2 - PRODUCTS

2.01 SURGE PROTECTION DEVICE

- A. Ratings: 120/208 and 277/480-volt grounded wye.
- B. Manufacturers: One of the following or equal:
 - 1. Square D SureLogic Model for switchgear installation.
 - 2. Siemens TPS series.
 - 3. Cutler Hammer CPS series.
 - 4. ABB OVRT1 series.
- C. Components:
 - 1. Fused disconnect for remote mounted units, breaker for integral mounted units.
 - 2. Status indicating pilot lights.
 - 3. Dry contacts.
 - 4. NEMA 1 stab-in housing compatible with switchgear.
- D. Characteristics:
 - 1. Single Pulse Surge Current Capacity per Phase: 200,000 amperes.
 - 2. Capacity Per Protection Modes:
 - a. L-N Mode: 100,000 amperes.
 - b. L-G Mode: 100,000 amperes.

- c. N-G Mode: 100,000 amperes.
 - d. L-L Mode: 100,000 amperes.
3. Surge Life Cycle: 1.2 by 50 micro-seconds 20 kilovolt open circuit voltage, 8/20 micro-second waveform 10 kiloamperes short circuit current Category C3 Bi-wave in accordance with ANSI C62.41 and C62.45.
 4. Suppression and Filter Technology: Manufacturer's standard.
 5. Continuous Operating Voltage: Minimum 115 percent of nominal.
 6. Suppression Voltage in Protective Modes: As follows when tested in accordance with UL 1449:
 - a. For 480 volt systems:
 - 1) L-N: 1200
 - b. For 208 volt systems:
 - 1) L-N: 800
 7. EMI/RFI High Frequency Noise Power Filter:

Frequency	100 KHz	1 MHz	10 MHz	100 MHz
Attenuation (dB)	34	51	54	48
Attenuation Ratio	50:1	350:1	500:1	250:1
 8. Minimum American Wire Gauge Copper in Surge or Noise Suppression Path: Number 6.
 9. Field Replaceable Fusing: Current limiting, protecting each pole.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install suppressors in accordance with manufacturer's instructions.

END OF SECTION

SECTION 265119

LIGHTING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of lighting fixtures, including:
 - 1. LED.
- B. Applications of lighting fixtures required for this Project include:
 - 1. Interior lighting.
 - 2. Exterior lighting.
 - 3. Emergency lighting.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013323, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's product data and installation instructions on each type lighting fixture and component. Assemble in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet. Indicate voltage, bulb type, and wattage.
 - 2. Illumination Data: Provide isofootcandle (isolux) plot diagram of footcandles on horizontal pavement surface which shows values of illuminance projected from indicated fixture heights for roadway and parking area lighting.
- B. Operation and Maintenance Manuals: submit in accordance with Section 017823, operation and maintenance manuals for items included under this Section. Include maintenance data and parts list for each lighting fixture and accessory, and troubleshooting maintenance guide

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/No. LE 2 pertaining lighting equipment.
2. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
3. UL Compliance: Comply with requirements of UL standards, including Standards 486A and B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL listed and labeled.
4. NFPA Compliance: Comply with applicable requirements of NFPA 78, "Lightning Protection Code," pertaining to installation of exterior lighting fixtures.
5. ANSI/NEMA C78-377-2008 Specification for the Chromaticity of Solid State Lighting Products.
6. ANSI/UL 8750-2009 Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.
7. IES Standard LM-79-08 - Electrical and Photometric Measurements of Solid State Lighting Products.
8. IES Standard LM-80-08 - Measuring Lumen Maintenance of LED Light Sources.
9. IES Standard LM-82-12 - Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature.
10. IES Standard RP-16-10 - Nomenclature and Definitions for Illuminating Engineering*.
11. IES Standard TM-21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources.
12. NEMA LSD 45-2009 - Recommendations for Solid State Lighting Sub-Assembly Interfaces for Luminaires.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. LED Lighting Fixtures:
 - a. Spaulding.
 - b. Hubbell.

- c. Cooper.
- d. Approved equal by others.

2.02 EXTERIOR LIGHTING FIXTURES

- A. Provide lighting fixtures of sizes, types, and ratings indicated on Luminaire Schedule on Drawings, complete with, but not limited to, housings, drivers, and wiring.

2.03 INTERIOR LIGHTING FIXTURES

- A. Provide lighting fixtures of sizes, types, and ratings indicated on Luminaire Schedule on Drawings.

2.04 EMERGENCY LIGHT SET, EXIT SIGN

- A. Self-contained, AC battery-illuminated exit sign unit, universal mounting. Provide NEMA enclosure rating suitable for the location in which unit is installed.
 - 1. Lamps: LED.
 - 2. Style, shape, trim, material, finish, and arrangement of housing as indicated.
 - 3. Faceplate: High-impact, UL 94 V-O rated, plastic with snap-out arrows and color of letters as indicated.
 - 4. Mounting provisions shall suit individual installation conditions.
 - 5. Battery: Sealed, maintenance-free, lead-acid or calcium type, with 10-year pro rata adjustment warranty or 5-year no charge replacement warranty.
 - 6. Charger: Minimum 2-rate, fully automatic, solid-state type with sealed transfer relay.
 - 7. Finish: Matte white for exposed parts, or as indicated.
 - 8. Operation: Sign is illuminated by AC-powered lamps under normal conditions. Relay turns emergency lamps on automatically when supply circuit voltage drops to 80 percent of nominal or below. Lamps operate for duration of outage, up to 1.5 hours. Lamps automatically disconnect from battery when voltage approaches deep-discharge value. When normal voltage is restored, AC-powered lamps are relighted and DC lamps are switched off. Battery is automatically recharged within 16 hours and maintained on trickle charge.

2.05 EXTRA MATERIALS

- A. Extra Stock: Furnish stock of replacement lamps amounting to 15 percent (but not less than 1 lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to OWNER's storage space and obtain receipt.

PART 3 - EXECUTION

3.01 INSTALLATION OF INTERIOR LIGHTING FIXTURES

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements. Field locate fixtures to avoid conflicts with equipment, pipework, etc.

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.callsunshine.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 and verified by Collier County Locate Department personnel before performing work. 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 numeric pager at 239-890-0809. **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 delay or denial of permit.

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 white 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:

		<u>Galvanized Steel</u>
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 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 intervals 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

NO TEXT FOR THIS PAGE

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 and a half inches (1.5").
- 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

NO TEXT FOR THIS PAGE

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

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

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
30"	42"	30"
36"	48"	36"
42"	54"	42"
48" – 54"	60"	48"
60" – 66"	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 331632

PRESTRESSED CONCRETE STORAGE TANK

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. This section specifies the design and construction of an ANSI/AWWA D110 wire-wound prestressed concrete storage tank with a Type II core wall and galvanized steel diaphragm including reinforced concrete dome, structural floor and all reinforcing, concrete work, accessories, disinfection and testing directly related to the tank.
- B. The tank contractor is responsible for furnishing all labor, materials, tools and equipment necessary to design and construct the prestressed concrete storage tank, including all coatings, as indicated on the drawings and as described in this specification.

1.2 RELATED SECTIONS

- A. Section 312316 – Excavation Earth and Rock.
- B. Appendix B – Geotechnical Report

1.3 REFERENCES

- A. ACI 117 – Specification for Tolerances for Concrete Construction and Materials
- B. ACI 301/301M – Specifications for Structural Concrete for Buildings
- C. ACI 305R – Guide to Hot Weather Concreting
- D. ACI 306R – Guide to Cold Weather Concreting
- E. ACI 347R – Guide to Formwork for Concrete
- F. ACI 350/350R – Code Requirements for Environmental Engineering Concrete Structures and Commentary
- G. ACI 350.3 – Seismic Design of Liquid-Containing Concrete Structures and Commentary
- H. ACI 372R – Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures
- I. ACI 506R – Guide to Shotcrete

- J. ACI 506.2 – Specification for Materials, Proportioning, and Application of Shotcrete
- K. ACI SP4 – Formwork for Concrete
- L. ANSI/AWWA C652 – Disinfection of Water Storage Facilities
- M. ANSI/AWWA D110 – Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks
- N. ASCE Standard 7 – Minimum Design Loads for Buildings and Other Structures
- O. ASCE 20 – Standard Guidelines for Design and Installation of Pile Foundations
- P. ASCE 24 – Flood Resistant Design and Construction
- Q. ASTM A416/A416M – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
- R. ASTM A475/475M – Standard Specification for Zinc-Coated Steel Wire Strand
- S. ASTM A603/603M – Standard Specification for Zinc-Coated Steel Structural Wire Rope
- T. ASTM A615/A615M – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- U. ASTM A653/653M – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by Hot Dip Process
- V. ASTM A821/A821M – Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks
- W. ASTM A884/A884M – Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement
- X. ASTM A1064/A1064M – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- Y. ASTM C31/C31M – Standard Practice for Making and Curing Concrete Test Specimens in the Field
- Z. ASTM C33/C33M – Standard Specification for Concrete Aggregates
- AA. ASTM C39/C39M – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- BB. ASTM C143/C143M – Standard Test Method for Slump of Hydraulic-Cement
- CC. ASTM C172/C172M – Standard Practice for Sampling Freshly Mixed Concrete

- DD. ASTM C231/C231M – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- EE. ASTM C881/C881M – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
- FF. ASTM D1056 – Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber
- GG. ASTM D1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
- HH. ASTM D4397 – Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
- II. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- JJ. AWS D1.2 – Structural Welding Code – Aluminum
- KK. "Earthquake Induced Sloshing in Tanks with Insufficient Freeboard" by P.K. Malhotra, Structural Engineering International, IASBSE, 3/2006 pp 222-225
- LL. OSHA 29 CFR 1910 – OSHA General Industry Regulations
- MM. U.S. Army Corps of Engineers CRD-C-572-74 – Specification for Polyvinylchloride (PVC) Waterstop
- NN. IBC 2018, Section 1810 – Deep Foundations
- OO. AMPP-QP8 Installation of Polymer Coatings and Surfacing on Concrete.
- PP. SSPC-SP 13/ NACE 6 Surface Preparation of Concrete.
- QQ. ICRI 310.2R-2013 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays and Concrete Repair.

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Shop Drawings: Provide shop drawings with a minimum size of 18" x 24" with a complete plan, elevation, and sectional views showing critical dimensions as follows:
 - 1. Size, location, and number of all reinforcing bars.

2. Thickness of all parts of the tank structure including floor, core wall, dome, and covercoat.
 3. Prestressing schedule including number and placement of prestressing wires on the tank wall and total applied force per foot of wall height.
 4. Location and details of all accessories required.
- B. Concrete Data: Submit concrete design mixes including ingredient proportions, minimum cementitious content, and water/cementitious ratio in accordance with Section 2.2 and 2.3 of this specification.
- C. Design Data: Submit structural calculations for the tank, signed and sealed by a professional engineer in accordance with Section 1.5 A.4 of this specification.
- D. Coating Data: Submit color charts for review by the engineer and owner. Once a color is chosen, submit actual drawdown samples for final approval prior to application of coating.
- E. Test Reports: Submit concrete strength reports for 7-day and 28-day breaks taken in accordance with the requirements of Section 3.3 A.1.
- F. Warranty Document: Submit warranty document in Owner's name in accordance with Section 1.6 A. of this specification.
- G. Cleaning and Disinfection Plan: Submit a cleaning and disinfection plan which complies with Section 3.4 of this specification.
- H. Project Record Documents: Record actual location layout and final configuration of tank and accessories on shop drawings and submit to engineer after construction of the tank is complete.

1.5 QUALITY ASSURANCE

A. Qualifications and Experience:

1. Tank Construction Company: Shall be a firm with a minimum of three years of experience in the design and construction of ANSI/AWWA D110 wire-wound, circular prestressed concrete tanks with Type II core walls to ensure the owner that it has the organization, technical skill, quality control, reliability, and financial stability to build and guarantee the tank in accordance with the quality required by these specifications. The tank construction company shall have built with its own resources and have under warranty, a minimum of ten (10) dome-covered prestressed concrete tanks of equal or greater size than that required for this project which meet these specifications and are now providing satisfactory service.
2. Construction: The entire tank, including all portions of the floor, wall, and roof shall be built by the tank construction company, using its own trained personnel and equipment.

3. Coatings: All Coating, Surface Preparation and Related Coating work shall be accomplished by an AMPP QP8 Certified Contractor. All tank coatings shall be included in the scope of the AMPP QP8 tank construction company. Subcontracting of this work is not allowed.
4. Design: All design work for the tank shall be performed by a professional engineer with no less than five years of experience in the design and construction of ANSI/AWWA D110 wire-wound, circular prestressed concrete tanks with Type II core walls. The professional engineer shall be a full-time staff member of the tank construction company and shall be licensed to work in the state where the project is located.
5. The diaphragm design and epoxy injection procedure shall have been used in the ten tanks required in Section 1.5 A.1 of this specification.

1.6 WARRANTY

- A. The tank construction company shall provide a warranty for workmanship and materials on the complete structural portion of the tank for a five-year period starting 6 months after demobilization, after a successful leak test, or substantial completion, whichever is sooner. The warranty shall not apply to any accessory, equipment or product that is not a structural part of the tank and is manufactured by a company other than the tank construction company. The tank construction company shall provide a written company warranty to cover this five-year period.
- B. If any leakage or other defects appear within the five-year period, the tank construction company shall promptly repair the tank at its own expense upon written notice by the Owner that such defects have been found. Leakage is defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from the inside of the tank. The tank construction company shall not be responsible for, nor liable for, any subsurface condition.
- C. The tank construction company shall install all tank coatings and shall provide a warranty for workmanship and materials on all interior and exterior coatings for a five-year period starting 6 months after demobilization, after a successful leak test, or substantial completion, whichever is sooner. The tank construction company and the coatings manufacturer shall provide a written company warranty to cover this five-year period.
- D. A coating system failure is defined as either (1) delamination of the coating, (2) a breach of the coating exposing the substrate below, or (3) chipping and peeling of the coating system not caused by physical damage or abrasion to the tank. Changes in color shall not be deemed a coating failure.

1.7 DESIGN CRITERIA

- A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures, ANSI/AWWA D110 Wire- and Strand-Wound, Circular,

Prestressed Concrete Water Tanks with Type II core walls, and currently accepted engineering principles and practices for the design of such structures.

B. The following loadings shall be utilized in the design:

1. Capacity: 500,000 Gallons
2. Dimensions: 55' Inside Diameter
3. Fluid Loads: Shall be the weight of all liquid when the reservoir is filled to capacity. The unit weight of the liquid material shall be 62.4 lbs/ft³.
4. Roof Live Loads: Consideration shall be given to all applicable roof design loads in accordance with ANSI/AWWA D110, Section 3.3 and ASCE 7, whichever applicable.
5. Dead Loads: Consideration shall be given to all permanent imposed loads including concrete and steel.
6. Seismic Loads:
 - a. Seismic forces and moments resulting from water sloshing and seismic accelerations of the tank dome, wall, and water loads shall be calculated in accordance with ACI 350.3 or ANSI/AWWA D110.
 - b. If sufficient freeboard height is not provided to prevent uplift forces due to sloshing, the impulsive participation shall be increased due to the constrained motion of liquid, and the tank roof and its connection shall be designed to resist the uplift forces in accordance with P.K. Malhotra's "Earthquake Induced Sloshing in Tanks with Insufficient Freeboard".
7. Soil Pressure: Earth loads shall be determined by rational methods of soil mechanics. Soil pressure shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.
8. Differential Backfill Loads: Forces from differential backfill loads shall be considered in the design and shall be based on the at-rest coefficient. Passive resistance shall not be used to resist differential backfill loads.
9. Wind Loads: Wind loads shall be considered in the design in accordance with ASCE Standard 7.

C. Structural Floor: The design of the structural floor for the prestressed concrete tank shall conform to the following:

1. Concrete structural floors shall contain a minimum reinforcing steel amount equal to 0.50% of the gross cross-sectional area. Reinforcing steel shall be placed orthogonally and distributed with at least 2/3 of the total minimum area required in the top face and 1/3 of the total minimum area in the bottom face.
2. Concrete sections that are 24 in. or greater in thickness may have the minimum percentages of reinforcing based on a 12 in. concrete layer at each face.
3. Minimum reinforcing size shall be #4 bar.
4. Maximum spacing of reinforcing steel for the structural floor shall be 12 in.
5. Concrete structural floors shall be designed to resist bending moments and shears induced by loadings specified in Section 1.7B. Pile Supported/Rock Anchor Structural Floor: Concrete structural floors shall be designed to resist bending moments and shears induced by loadings required in Section 1.7B. Moments and shears shall be

calculated based on rational analysis utilizing an influence area derived from the pile spacing plus 2 times the pile spacing tolerance specified in Section 1.7C8.

6. Circumferential steel shall be added to the outside edge of the structural floor to resist circumferential bending moments that occur at the free edge of the circular plate. Circumferential steel shall be as calculated by rational analysis with a minimum amount of 0.50% of the gross cross sectional area and placed within a minimum width of 2' 6", but not to extend inside of the thickened edge of the floor. Minimum circumferential steel shall be distributed with 2/3 of the total area required in the top face and 1/3 in the bottom face. Pile Supported/Rock Anchor Structural Floor: Circumferential steel shall be added to the outside edge of the structural floor as required to resist calculated bending moments in spans between perimeter piles. Circumferential steel required for bending moments shall be calculated by any rational one-way analysis with a minimum required amount of 0.50% placed in a minimum width of 2' 6", but not to extend inside of the thickened edge of the floor nor 1/4 of a typical interior pile spacing. Minimum circumferential steel shall be distributed with 2/3 of the total area required in the top face and 1/3 in the bottom face.
7. Pile Supported/Rock Anchor Structural Floor: Radial steel shall be added to the top and bottom mats of reinforcing steel at the edge of the structural floor to account for edge effects in the circular plate. Edge effects shall include moments at the mid-span of the outer most span and the outside face of the first interior support of a two-way slab and shall be calculated by any rational analysis which considers these effects.
8. Pile Supported Structural Floor: Minimum pile embedment shall be into the concrete structural floor shall be 3 in. for concrete auger cast piles, drilled piers and timber piles and 6 in. for steel H-piles.
9. Pile Supported Structural Floor: Minimum spacing tolerance shall be 6 in. for all driven piles, 3 in. for all auger cast piles and drilled piers or as defined by the geotechnical design professional.

D. Core Wall:

1. The wire-wound, prestressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, galvanized steel shell diaphragm.
2. The design of the core wall shall take into account appropriate edge restraint. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following minimum reinforcing steel shall be incorporated into the design:
 - a. The top 2 ft of core wall shall have not less than 1% circumferential reinforcing.
 - b. The bottom 3 ft of core wall shall have not less than 1% circumferential reinforcing.
 - c. Inside Face:
 - (1) The inside face of the core wall shall utilize the diaphragm as effective reinforcing.
 - (2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.

- d. Outside Face:
 - (1) Vertical reinforcing steel in the outside face of the core wall shall be: minimum of #4 bars at 12 in. center to center.
 - (2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
 - 3. The minimum core wall thickness shall be 3½ in.
 - 4. Reinforcing steel used in the core wall shall be designed using a maximum allowable design tensile stress, f_s , of 18,000 psi.
 - 5. Allowable compressive stress in the core wall due to initial prestressing force, f_{gi} , shall be:
 - a. 1250 psi + 75t psi/in. with 0.5 f'_{gi} maximum or less (where f'_{gi} is defined as compressive strength at time initial prestressing force is applied and t is the thickness of the core wall in inches).
 - b. Maximum of 2250 psi.
 - 6. Allowable compressive stress in the core wall due to final prestressing force, f_g , shall be:
 - a. 1250 psi + 75t psi/in. with 0.45 f'_g maximum (where f'_g is defined as compressive strength required for final prestressing force and t is the thickness of the core wall in inches).
 - b. Maximum of 2025 psi.
- E. Dome:
- 1. The dome roof shall be constructed of reinforced concrete and shall be circumferentially prestressed.
 - 2. Dome shell reinforcement shall consist of reinforcing bars or welded wire fabric, not galvanized. Bolsters for wire fabric and reinforcing bars shall be plastic. Wire ties shall be galvanized.
 - 3. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have cross section suitable to accept the applied prestressing forces.
 - 4. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.
 - 5. Overflow outlets or the overflow pipe shall be capable of providing an overflow open area three times the area of the largest influent pipe.
 - 6. Overflow outlets plus the dome ventilator shall be capable of providing an open area three times the area of the largest pipe.
 - 7. The dome shall be designed as a free-span, spherical thin shell with one-tenth rise in accordance with the following:
 - a. Typical Dome Design: The typical dome thickness and steel reinforcement shall meet the requirements of ANSI/AWWA D110.
 - b. In all cases, the thickness of the dome shall be no less than 3 in.
 - c. Dome Edge Design: The dome edge and upper wall shall be designed to resist the moments, thrusts, and shears that occur in this region due to dome and wall prestressing and loading conditions. The design of the edge region shall conform to the following:

(1) Dome Edge Thickness:

- (a) A determination of the buckle diameter shall be made, as defined by:

$$d_b = 2.5 \cdot \sqrt{r_d \cdot t_d} \text{ rounded up to the next foot}$$

Where: d_b = buckle diameter in feet

r_d = dome radius in feet

t_d = typical dome thickness in feet

- (b) Dome edge thickening shall begin at a radial location on the dome, defined as s_2 which is at least one buckle diameter away from the tank wall.
- (c) A springline haunch shall be provided, which extends radially from the inside face of the tank wall to radial location s_1 which is defined as:

$$s_1 = 0.6 \cdot \sqrt{1.5 \cdot r_d \cdot t_d} \text{ rounded up to the next foot}$$

Where: s_1 = distance from inside face of wall to haunch in feet

s_2 = distance from inside face of wall to typical dome thickness in feet

This springline haunch shall begin at the inside face of the tank wall with a springline thickness as required by paragraph (f) below and shall end at radial location s_1 with the following thickness:

$$t_{d1} = 1.33 \cdot t_d$$

Where: t_{d1} = minimum thickness at s_1 in feet

t_d = typical dome thickness in feet at one buckle diameter from tank wall

- (d) Beginning at s_1 and continuing to s_2 the dome shell shall have a uniform straight line taper.
- (e) Parameters (b), (c), and (d) above are not required for domes where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.
- (f) Sufficient concrete thickness at the springline of the dome shall be provided so that no more than 2 ft of the springline haunch is considered in calculating the effective dome edge ring cross sectional area. Compressive stress in this area shall not exceed 1000 psi when subjected to initial prestressing, offset by dead load only.

(2) Dome Edge Steel Reinforcement:

- (a) Throughout the dome edge, the percentage of steel reinforcement, both radially and circumferentially, shall be no less than 0.25% of the gross cross sectional area of concrete.
- (b) Along the dome edge, steel reinforcement shall be distributed between the upper and lower layers unless finite element analysis calculations indicate that tensile stress does not exist in the concrete along the bottom face of the dome edge. In that case, only top bars are required radially and circumferentially. In addition, radial and circumferential reinforcing bars will not be required along the bottom face of the dome edge where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.
- (c) Where reinforcing bars are required in the bottom layer, they shall be placed near the tank wall to insure adequate development at the intersection between dome and wall.
- (d) In all cases, the percentage of circumferential steel reinforcement in the effective dome ring shall be no less than one percent of the gross cross sectional area of concrete. The effective dome ring is defined as $\frac{1}{4}$ of the haunch length not to exceed 2 ft.
- (e) Where bottom dome edge steel reinforcement is required, vertical steel reinforcement along the inside face of the tank wall shall be no less than 0.5% of the cross sectional area of wall shotcrete.

F. Prestressing:

- 1. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire placed under high tension.
- 2. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.
- 3. The prestressing design shall conform to the following minimum requirements:
 - a. Working stress for the tank wall, f_s , shall be a maximum of 115,000 psi.
 - b. Working stress for the dome ring, f_{sd} , shall be a maximum of 120,000 psi.
 - c. The allowable design tensile stress in the prestressing wire before losses, f_{si} shall be 145,600 psi or no greater than $0.63 f_u$, where f_u is defined as the ultimate strength of the wire.
 - d. Areas to be prestressed will contain no fewer than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge.
 - e. A maximum of 24 wires per layer per foot for 8 gauge and 20 wires per layer per foot for 6 gauge will be allowed.

G. Wall Openings:

- 1. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall provide no less than 18 in. of prestressing above at the bottom of the wall. The prestressing wires required at the pipe elevation shall be distributed into circumferential bands immediately above and below the opening to maintain the required prestressing force while leaving an unbanded strip around the entire tank.

2. Unbanded strips shall have a vertical dimension of no more than 36 in. unless an axis-symmetric shell analysis is performed to account for compressive forces plus shear and moments caused by displacement of the prestressing wires into adjacent bands.

PART 2 PRODUCTS

2.1 PERFORMANCE

- A. Performance of the materials used in the tank construction shall conform to the minimum requirements of this specification.
- B. Substitutions to the materials in this specification may only be made if submitted in writing and approved by the engineer.

2.2 CONCRETE

- A. Concrete shall conform to ACI 301/301M.
- B. All concrete shall utilize either Type I/II or Type IL Portland cement.
- C. A maximum of 25% of cementitious material may be fly ash.
- D. Admixtures other than air-entraining and water reducing admixtures will not be permitted unless approved by the engineer.
- E. Coarse and fine aggregate shall meet the requirements of ASTM C33/C33M.
- F. Concrete mixes used in the construction of the tank shall conform to the following:

Mix	Compressive Strength (psi)	Minimum Cement Content (lbs)	AASHTO Aggregate	Maximum W/C Ratio	Air Content (%)	Slump (in)
Floor	4000	560	#57	0.45	5 +/- 1.5	4" +/- 1"
Dome	4000	600	#8	0.45	5 +/- 1.5	4" +/- 1"

2.3 SHOTCRETE

- A. Shotcrete shall conform to the requirements of ACI 506.2 except as modified herein.
- B. All shotcrete mixes shall utilize either Type I/II or Type IL cement.
- C. A maximum of 25% of cementitious material may be fly ash.
- D. All shotcrete in contact with diaphragm or prestressing wire shall be proportioned to consist of not more than three parts sand to one part Portland cement by weight. All

other shotcrete shall be proportioned to consist of not more than four parts sand to one part Portland cement by weight.

- E. Admixtures will not contain more than trace amounts of chlorides, fluorides, sulfides or nitrates.
- F. Fine aggregate shall meet the requirements of ASTM C33/C33M.
- G. Shotcrete mixes used in the tank construction shall conform to the following:

Mix	Compressive Strength (psi)	Maximum W/C Ratio	Air Content (%)	Slump (in)	Fiber Reinforcement (lbs/cyd)
Core Wall	4000	0.42	5 +/- 1.5	5"+/-1"	-
Covercoat	4000	0.42	5 +/- 1.5	5"+/-1"	

2.4 MOISTURE BARRIER

- A. The moisture barrier shall be polyethylene, Class A, conforming to ASTM D4397 with a minimum thickness of 6-mils.

2.5 PRESTRESSED REINFORCEMENT

- A. The prestressing wire shall conform to the requirements of ASTM A821/A821M, Type B.
- B. The prestressing wire size shall be 0.162 in. (8 gauge), 0.192 in. (6 gauge) or larger, but no larger than 0.250 in.
- C. The ultimate tensile strength, f_u shall be, 231,000 psi or greater for 8 gauge wire, 222,000 psi or greater for 6 gauge.
- D. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the prestressing reinforcement and shall develop the full strength of the wire.

2.6 NON-PRESTRESSED REINFORCEMENT

- A. Non-prestressed mild reinforcing steel shall be new billet steel meeting the requirements of ASTM A615/A615M with a minimum yield strength, f_y , of 60,000 psi.
- B. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A1064/A1064M with a minimum yield strength, f_y , of 65,000 psi.

2.7 GALVANIZED STEEL DIAPHRAGM

- A. The galvanized steel diaphragm used in the construction of the core wall shall be 26 gauge with a minimum thickness of 0.017 in. conforming to the requirements of ASTM A653/A653M. Weight of zinc coating shall be not less than G90 of Table 1 of ASTM A653/A653M.

- B. The diaphragm shall be formed with re-entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm.
- C. The diaphragm shall be continuous to within 3 inches of the top and bottom of the wall. Horizontal joints or splices will not be permitted.
- D. All vertical joints in the diaphragm shall be rolled seamed, crimped, and sealed watertight using epoxy injection.
- E. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to the waterstop.

2.8 PVC WATERSTOPS, BEARING PADS AND SPONGE FILLER

- A. Plastic waterstops shall be extruded from an elastomeric plastic material of which the base resin is virgin polyvinylchloride (PVC). PVC waterstops shall conform to the requirements of CRD-C-572-74.
- B. The profile and size of the waterstop shall be suitable for the hydrostatic pressure and movements to which it is exposed.
- C. Bearing pads used in floor/wall joints shall consist of neoprene, natural rubber or polyvinyl chloride.
- D. Sponge filler at the floor/wall joint shall be closed-cell neoprene. Sponge filler shall conform to the requirements of ASTM D1056

2.9 EPOXY

A. Epoxy Sealants:

- 1. Epoxy shall conform to the requirements of ASTM C881/C881M.
- 2. Epoxy used for sealing the diaphragm shall be, Type III, Grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy.
- 3. Epoxy used for placing the waterstop shall be Type II, Grade 2, and shall be 100% solids, moisture insensitive, low exotherm epoxy.
- 4. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.
- 5. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC, and steel.

B. Bonding Epoxy:

- 1. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to the requirements of ASTM C881/C881M.
- 2. Epoxy resins shall be a two-component, 100% solids, moisture-insensitive epoxy and shall be Type II, Grade 2.

2.10 TANK ACCESSORIES

- A. Minimum of one, 1' 5" x 4' 4" rectangular Type 316 stainless steel wall manhole for access to the interior of the tank. The cover shall also be of Type 316 stainless steel. The wall manhole shall be designed to resist hydraulic loading without excessive deflection.
- B. Aluminum accessories
 - 1. Exterior ladder shall be fabricated from 6061-T6 and 6063-T6 aluminum and shall conform to all applicable OSHA standards. The ladder shall have an aluminum safety cage and lockable security gate and/or a safety climbing device in accordance with all applicable OSHA standards.
 - 2. Aluminum handrail shall be fabricated in 20 ft typical sections from 6061-T6 aluminum and shall conform to all applicable OSHA standards.
 - 3. Aluminum accessories shall be shop fabricated and fully welded. All welding shall be in accordance with American Welding Society (AWS) D1.2 to fuse materials without distortion of the material. Mechanical splices shall only be used at field splice locations.
 - 4. Aluminum accessories shall have a "mill" finish.
 - 5. Aluminum surfaces in contact with concrete shall be protected with a coat of bituminous paint.
- C. Interior ladder shall be fabricated from fiberglass and shall conform to all applicable OSHA standards. The ladder shall have a safety climbing device manufactured from Type 316 stainless steel as required to meet applicable OSHA standards.
- D. Roof hatch cover, roof ventilator, and liquid level indicator shall be fabricated from fiberglass.
- E. Through-wall pipe shall be Type 316 stainless steel. Waterstop rings on wall-pipes shall be Type 316 stainless steel.
- F. Accessory hardware, unless otherwise noted, shall be Type 316 stainless steel conforming to ASTM F593.

2.11 COATINGS

- A. Interior and exterior tank colors shall be selected by Owner during the shop drawing process
- B. Exterior Coatings
 - 1. Exterior tank walls and dome
 - a. Surface Preparation: Remove all contaminants by power washing per SSPC-SP13/NACE 6. SSPC-SP1 is included in all SP Standards.
 - b. First Coat: Tnemec Series 156 Enviro-Crete 4.0 to 6.0 mils DFT

- c. Second Coat: Tnemec Series 156 Enviro-Crete 4.0 to 6.0 mils DFT

PART 3 EXECUTION

3.1 EXAMINATION

- A. All subgrade elevations shall be verified prior to starting tank construction.

3.2 INSTALLATION

A. Floor:

1. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.
2. Form and screed boards shall be of proper thickness and sufficiently braced to ensure that the floor is constructed within proper thickness tolerances.
3. Plate bolsters shall be used to support reinforcing steel supported directly on the subgrade to ensure positive control of placement of reinforcing steel.
4. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.
5. The floor shall be water cured for a minimum of 7 days after casting.
6. The floor shall receive a light broom finish.

B. Core Wall:

1. The wall shall be constructed in utilizing diaphragm and shotcrete with each conforming to the following:
 - a. Diaphragm Erection:
 - (1) The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the diaphragm for erection except in the top 3 inches. Holes shall not be made in the diaphragm except for inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an epoxy sealant which complies with Section 2.9 Epoxy.
 - b. Shotcrete:
 - (1) All shotcrete shall be applied by or under direct supervision of experienced nozzle men certified according to the applicable requirements of ACI 506R.
 - (2) Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.
 - (3) No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.
 - (4) No less than $\frac{1}{8}$ in. thick shotcrete shall separate reinforcing steel and prestressing wire.
 - (5) The diaphragm shall be encased and protected with no less than 1 in. of shotcrete in all locations.

- (6) The interior shotcrete shall receive a light broom finish.
- c. Curing:
 - (1) Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is completed.
- C. Epoxy Injection:
1. Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure.
 2. Epoxy injection shall proceed only after the diaphragm has been fully encased, inside and outside, with shotcrete.
- D. Dome:
1. All concrete shall be consolidated by means of a vibrator for proper encasement of reinforcing steel and welded wire fabric.
 2. All surfaces at the joint between the wall and the dome shall be coated with bonding epoxy which complies with Section 2.9 Epoxy.
 3. Plastic bolsters shall be used to support reinforcing steel and welded wire reinforcement to ensure positive control on placement of steel.
 4. The exterior surface of the dome shall receive a light broom finish.
 5. The dome shall be water cured for a minimum 7 days after casting or until dome band prestressing is completed.
- E. Prestressing:
1. The initial tension in each wire shall be read and recorded to verify that the total aggregate force is no less than that required by the design. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.
 2. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive force equal to that shown on the design drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire or when removing a defective section of wire.
 3. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.
 4. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the design and as shown on approved drawings.
 5. The tank construction company shall supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. The stress

measuring equipment shall include: electronic direct reading stressometer accurate to within 2%, calibrated dynamometers and a test stand to verify the accuracy of the equipment.

6. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.
7. When multiple layers of wire are required, shotcrete cover between layers shall be no less than $\frac{1}{8}$ in. thick.

F. Covercoat:

1. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1 in. shall be placed over the prestressing wires.
2. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.
3. The covercoat shall receive a sliced trowel finish.

G. Wall Openings:

1. All wall pipes, sleeves and manholes passing through the wall shall be sealed to the diaphragm by epoxy injection.

H. Coatings:

1. The coatings of the tank (concrete surfaces and metallic surfaces) shall be self-performed by the tank construction company. The tank construction company shall be QP-8 certified and have system responsibility for all coatings. If the tank construction company is not QP-8 certified, then a Senior Certified Coatings Inspector (CIP Level 3) shall be present full-time during the coatings application.
2. Exterior coatings shall be applied in accordance with the manufacturer product data sheet after final application of concrete or shotcrete
3. All application procedures for coatings shall meet the requirements of Section 2.12 and the manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Concrete and Shotcrete Testing:

a. Compression Tests:

- (1) Compression test specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 50 yards of concrete/shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.

- (2) Compression test specimens for concrete/shotcrete shall conform to ASTM C172/C172M for sampling and ASTM C31/C31M for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.
 - (3) Compression test shall be performed in accordance with ASTM C39/C39M. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.
 - b. Air Content Tests (concrete only):
 - (1) Air content tests shall conform to ASTM C231/C231M (Pressure Method for Air Content).
 - (2) Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.
 - c. Slump Tests (concrete only):
 - (1) Slump tests shall be made in accordance with ASTM C143/C143M.
 - (2) Slump tests shall be made whenever compression test specimens are made.
- 2. Hydrostatic Testing:
 - a. The tank shall be tested for watertightness upon completion.
 - b. The testing for watertightness shall be completed as follows:
 - (1) Fill the tank with water to the maximum water level and let it stand for a minimum of 24 hours.
 - (2) Inspect the exterior of the tank wall and footing for damp spots. Damp spots shall be defined as spots where moisture can be picked up on a dry hand, the source of which is from inside the tank.
 - (3) Leakage through the wall or wall-base joint shall be repaired and the tank shall be retested using the above procedure.

B. Coating Inspection and Testing:

- 1. All surface preparation, coatings application and coatings related work shall be supervised by an AMPP C-11 Concrete Coatings Inspector Level II.
- 2. All exterior coatings shall be final inspected by the AMPP C-11 Concrete Coatings Inspector and found holiday free prior to owners' acceptance.

3.4 CLEANING AND DISINFECTION

- A. The interior of the tank shall be cleaned to remove debris, construction items, and equipment prior to testing and disinfection.
- B. The following disinfection procedure shall be used to disinfect storage tanks used for potable water:
 - 1. Method 2 or 3 will be used for disinfection of the tank in accordance with ANSI/AWWA C652.
 - 2. When Method 3 is used, the disinfection plan required by Section 1.4 H. shall address any compatibility issues with the form of chlorine used for disinfecting the storage

tank with the type of disinfectant used in the normal production of the water used to fill the tank.

END OF SECTION 33 16 32.13

SECTION 406113

BASIC INSTRUMENTATION REQUIREMENTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a complete and operating instrumentation and control system.
2. The Work includes, but is not limited to, the following:
 - a. New pump station control panel with Compact Logix PLCs, network switches, and fiber communication.
 - b. New field control panels with instrument transmitters, network switches, and fiber communication.
 - c. Update existing SCADA system, reporting, and historian.
 - d. New SCADA system screens for pump station and electrical system.
 - f. New field and panel mounted instruments.
 - g. Ethernet and Hardwiring cabling, terminations and testing.
 - h. Local area network hardware and software and media converters.
 - i. Ethernet/ Fiber network communication hardware and software required for interfacing various systems to provide one fully integrated system.
 - j. Work outlined in Section 406166 Software Services.
 - k. Package System Integration:
 - 1) Contractor is responsible for coordinating data exchange with vendor control panels on the plant network.
 - 2) Recreate all graphic screens for all vendor package system on the SCADA system. Obtain a copy of the graphic screens and PLC logic from the package system supplier for development of similar graphics on the plant SCADA system.

3. Contractor shall turn over all native, uncompiled source files for HMI's and PLC's for unrestricted use by Owner. Provide Files on USB drive. Provide a list of all usernames, passwords and IP addresses used as part of the documentation.
4. Integrator shall use County's tag naming convention as provided in the appendix of these specifications.

B. Coordination:

1. Existing Conditions:
 - a. The existing SCADA system is GE iFIX SCADA system located offsite.
2. Instrumentation and Controls:
 - a. Providing Panels, cabling, termination for instruments, and controls are part of the Work by instrumentation and controls (I&C) Subcontractor. Programming of control logic and configuration of human machine interface (HMI) software is part of the Work. Functional description of process system and associated equipment is included in Section 406196.
 - b. SCADA system input/output list identifies inputs and outputs required and is part of this Section. Input/output list is for coordinating signals between equipment provided by others and computer system Supplier, and identifying signals to be programmed by Contractor's configuration Subcontractor. Include Work for Contractor-furnished control options not on the input/output list at no additional cost to Owner.
3. The Plant Fiber Optic Network (SCADA, Security, County WAN) will be provided by the Telecommunications subcontractor. The I&C subcontractor will be responsible for coordinating the SCADA portion of the network.
3. To centralize responsibility, materials and equipment provided under this Section shall be furnished by a single Supplier.
4. With Contractor, Supplier shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.
5. To the greatest extent possible, provide materials and equipment from a single manufacturer.
6. Supplier's Responsibilities:
 - a. Preparing all instrumentation and control equipment submittals in accordance with the Contract Documents.
 - b. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, panels, and required interfacing with the Site's electrical system.

- c. Review and coordination with manufacturers, Suppliers, and other contracts of Shop Drawings and other Contractor submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.
- d. Direct, detailed oversight of installation of instruments, panels, cabinets, wiring and other components, and related wiring and piping connections.
- e. Calibrating, configuration, source quality control, field quality control, and start-up of the system.
- f. Responsibility for correction period obligations for instrumentation and control system.
- g. Training of operations and maintenance personnel in operation and maintenance (including calibration and troubleshooting) of the instrumentation and control system.

1.02 REFERENCES

A. Standards referenced in this Section are:

- 1. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.
- 2. ASTM A269, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- 3. ASTM A312, Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- 4. ASTM A403, Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- 5. ASTM B88, Specification for Seamless Copper Water Tube.
- 6. IEEE 802.1 LAN/MAN Bridging & Management
- 7. IEEE 802.1X, Port Based Network Access Control.
- 8. IEEE 802.3, Standards Defining Physical Layer and Data Link Layer Media Access Control (MAC) Sublayer of Wired Ethernet.
- 9. ISA 5.1, Instrumentation Symbols and Identification.
- 10. ISA 5.4, Instrument Loop Diagrams.
- 11. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.

12. ISO 8802-3, 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.
13. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NFPA 70 (NEC), Article 770, Optical Fiber Cables and Raceways.
15. NFPA 79, Electrical Standard for Industrial Machinery.
16. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
17. UL 50, Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
18. UL 508A, Industrial Control Panels.
19. UL 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
20. UL 2062, Enclosures for Use in Hazardous (Classified) Locations.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Supplier:

- a. Shall be financially sound with at least five years continuous experience in designing, implementing, supplying, and supporting instrumentation and control systems for municipal water and wastewater treatment facilities comparable to the instrumentation and control systems required for the Project, relative to hardware, software, cost, and complexity.
- b. Shall have record of successful instrumentation and control system equipment installations. Upon Engineer's request, submit record of experience listing for each project: project name, owner name and contact information, name and contact information for contractor, name and contact information for engineer, approximate contract value of instrumentation and controls Work for which Supplier was responsible,
- c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.

- d. Shall be capable of training operations and maintenance personnel in instrumentation and control applications, and in operating, programming, and maintaining the control system and equipment.
 - e. Shall have OR utilize a UL-approved panel shop.
- 2. Manufacturer: Manufacturers of instrumentation and control equipment furnished under this Section shall be experienced producing similar equipment and shall have the following qualifications:
 - a. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
 - b. Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
 - c. Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
 - d. Shall have documented product safety policy relevant to products proposed for the Work.

B. Pre-submittal Conference

- 1. Schedule and conduct pre-submittal conference for instrumentation and control system within 30 days after acceptance of I&C Subcontractor by Owner.
- 2. Required attendance for pre-submittal conference: Contractor, I&C Subcontractor, Engineer, and Owner. Pre-submittal conference will be 4 hours. Conference will be held at Owner/ Engineer desired or approved location.
- 3. Purpose of pre-submittal conference is to review manner in which I&C Subcontractor intends to comply with requirements of the Contract Documents before submittals are prepared.
- 4. Prepare items listed below for presentation at pre-submittal conference. Submit information to Engineer two weeks prior to pre-submittal conference.
 - a. List of materials and equipment required for instrumentation and control system, and brand and model proposed for each item.
 - b. List of proposed exceptions to the Contract Documents along with brief explanation of each.
 - c. Sample of each type of submittal specified in this Section. These may be submittals prepared for other projects.
 - d. Flow chart showing steps to be taken in preparing and coordinating instrumentation and control system submittals.

- e. General outline of types of tests to be performed to verify that all sensors and transducers, instruments, and digital processing equipment are functioning properly.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Field Instruments:

- 1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
- 2) Instrument tag number in accordance with the Contract Documents.
- 3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
- 4) Description of construction features.
- 5) Performance and operation data.
- 6) Installation, mounting, and calibration details; instructions and recommendations.
- 7) Service requirements.
- 8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
- 9) Range of each device and calibration information
- 10) Descriptions of materials of construction and listing of NEMA ratings for equipment

b. Panels and Cabinets:

- 1) Layout drawings that include:
 - a) Front and internal panel views to scale.
 - b) Tag number and functional name of components mounted in and on panel or cabinet, as applicable.

- c) Product information on panel components.
 - d) Nameplate location and legend including text, letter size and colors to be used.
 - e) Location of anchorage connections.
 - f) Location of external wiring and piping connections.
 - g) Mounting and installation details, coordinated with actual application.
 - h) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.
 - i) Calculations for heating and cooling of panels, as applicable.
 - j) Subpanel layouts and mounting details for items located inside control panels.
- 2) Product information on panel components including:
- a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
 - b) Instrument tag number in accordance with the Contract Documents.
 - c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
 - d) Description of construction features.
 - e) Performance and operation data.
 - f) Installation, mounting, and calibration details; instructions and recommendations.
 - g) Service requirements
- 3) Wiring and piping diagrams, including the following:
- a) Name of each panel, console, or cabinet.
 - b) Wire sizes and types.

- c) Pipe sizes and types.
 - d) Terminal strip and terminal numbers.
 - e) Wire color coding.
 - f) Functional name and manufacturer's designation for components to which wiring and piping are connected.
 - g) Lightning and surge protection grounding, refer to Electrical specification Section 26 05 26, Grounding and Bonding for Electrical Systems and drawings.
- 4) Electrical control schematics in accordance with NFPA 79. Drawings shall be in accordance with convention indicated in Annex D of the NFPA 79. Typical wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.
- 5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.
- 6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.
- c. Field wiring and piping diagrams, include the following:
 - 1) Wire and pipe sizes and types.
 - 2) Terminal numbers at field devices and in panels.
 - 3) Fiber optic termination designations in the field and in panels.
 - 4) Color coding.
 - 5) Conduit numbers in which wiring will be located.
 - 6) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.
- d. Submit proposed HMI & OIT graphics layouts for approval; all equipment screens shall be added as part of this project. Each graphic display and process report layout will be subject to modification from Contractor's submitted format within limits of software package used for development. Implement such modifications in accordance with Owner/Engineer's comments.

e. Supervisory Control and Data Acquisition (SCADA) System Modifications:

1) Submit the following general information:

- a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.
- b) Software listings for operating system, applications, and HMI.
- c) Software language and organization.
- d) Format, protocol and procedures for data transmission and communications with input/output modules and peripheral devices, including local area network (LAN).
- e) HMI interfacing details, licensing structure, and included functions.
- f) Control and failure modes.
- g) Input/Output Information:
 - i. Input/output (I/O) point listing with I/O module cross-reference identification.
 - ii. I/O module cross-reference identification based on I/O address list developed by I&C Subcontractor .
- h) Database listing, including all I/O points.
- i) Format and configuration of log reports, alarm summaries, printer outputs, displays, and graphics shall match the existing. Examples can be provided if requested.

2) Hardware:

- a) Layout drawings showing front, rear, end and plan views to scale of equipment, I/O components, power supplies, and peripheral devices.
- b) Equipment ventilation requirements.
- c) Interconnection diagrams, including termination details, cable identification list, and cable length.
- d) Drawings showing equipment layout.

- e) Installation requirements, instructions, and recommendations.
- 3) Software:
- a) Licensing agreement with name of licensee, renewal requirements, release and versions, expiration dates (if any) and upcoming releases scheduled before Project completion. When upcoming releases are expected, provide descriptions, when available, of features that differ from the proposed release.
 - b) Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging and storage and diagnostic functions. Submit this information on electronic media.
 - c) Standard technical documentation covering all aspects of the computer system software functions and capabilities, including instruction set description and programming procedures related to monitoring, display, logging, reporting and alarming functions.
 - d) Detailed functional descriptions of application programs explaining control, display, logging and alarming features to be provided and functions to be performed.
- 4) Documentation describing memory type, size and structure and listing size of system memory, I/O and Data Table memory and size of memory available for control programs shall be provided upon updating the existing software.
- 5) New System I/O Loop Wiring Diagrams: Prepare Shop Drawings on module-by-module basis and include the following information:
- a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
 - b) Wiring types, wire numbers, and color coding.
 - c) Designation of conduits in which field I/O wiring will be installed.

- d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
 - e) Prepare loop wiring diagrams in accordance with ISA 5.4.
- f. Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
 - 1) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, VFD's, and motor starters. Some of this equipment may be specified in other Divisions, Contractor is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
 - 2) Numbered terminal block and terminal identification for each wire termination.
 - 3) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
 - 4) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
 - 5) Junction and pull boxes through which wiring will be routed.
 - 6) Identification of equipment in accordance with the Contract Documents.

2. Product Data:

- a. Product data for field instruments in accordance with requirements for Shop Drawings in this Section.
- b. Product data for panels, and cabinets in accordance with requirements for Shop Drawings in this Section.
- c. Product data for field wiring and piping provided for instrumentation and control service and not included under other Sections or contracts.
- d. Product data for SCADA system, including software and hardware. Requirements for software product data are included in requirements for Shop Drawings under this Section.

3. Samples:

- a. Color charts for finish paint for panels. Provide full range of paint manufacturer's standard and custom colors. Color selection will be by Engineer.
 - b. Color charts for FRP panels. Provide full range of panel manufacturer's standard and custom colors. Color selection will be by Engineer.
- 4. Factory Acceptance Test Procedure: Submit factory testing procedures that will be performed to fulfill requirements of the Contract Documents. Test procedure shall include the following:
 - a. Visual inspection of components and assembly.
 - b. Description of hardware operational testing.
 - c. Description of software demonstration.
 - d. Description of testing equipment to be used.
 - e. Sign-off sheets to be used at time of testing.
- B. Informational Submittals: Submit the following:
 - 1. Documents to be submitted prior to pre-submittal conference, in accordance with Article 1.03 of this specification.
 - 2. System Software Documentation: Submit preliminary software documentation not later than four weeks prior to scheduled start of factory testing. Software documentation shall include the following:
 - a. Complete printed copies of all programming.
 - b. Complete listing of external and internal I/O address assignments, register assignments and preset constant values with function point descriptions. List unused/undefined I/O and data table registers available.
 - c. Copies of all configured HMI screens.
 - 3. Manufacturer's Instructions:
 - a. Shipping, handling, storage, installation, and start-up instructions.
 - 4. Source Quality Control Submittals:
 - a. Factory test reports and results.
 - 5. Special Procedure Submittals:

- a. Submit notification to Owner and Engineer at least 14 days before readiness to begin system checkout. Schedule system checkout on dates agreed to by Owner and Engineer.
 - b. Submit written procedure for system checkout to Engineer three months prior to starting system checkout. Three months prior to starting system checkout submit written procedure for start-up to Engineer.
- 6. Field Quality Control Submittals:
 - a. Submit the following prior to commencing system checkout and start-up.
 - 1) Completed calibration sheets for each installed instrument showing five-point calibration (0, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
 - b. Field calibration reports
 - c. Field testing reports.
- 7. Supplier's Reports:
 - a. Installation inspection and check-out report.
 - b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 8. Qualifications Statements:
 - a. Supplier.
 - b. Manufacturer, when required by Engineer.
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 017823 - Operation and Maintenance Data.
 - b. Include complete up-to-date system HMI, PLC software documentation. Provide hardcopy and electronic copies.
 - c. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
 - 2. Record Documentation:

- a. Prepare and submit record documents in accordance with 017839 - Project Record Documents.
- b. Revise all system Shop Drawing submittals to reflect as-built conditions in accordance with the following.
 - 1) Two copies of each revised Shop Drawings and documentation to replace out-dated drawings and documentation contained in operation and maintenance manuals. Submit half-size black line drawings for each drawing larger than 11 inches by 17 inches. Include specific instructions for out-dated drawing removal and replacement with record documents submittal.
 - 2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes and stored in a suitable print pocket or container inside each control panel.
 - 3) Submit CADD drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:

1. Spare Parts and Test Equipment

a. General

- 1) Furnish the spare parts and test equipment as indicated below, identical to and interchangeable with similar equipment provided under this Section.
- 2) Provide source quality control for spare parts as part of factory testing prior to shipment of instrumentation and control equipment.
- 3) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of equipment installation and that Supplier understands that Owner reserves the right to purchase none, any, or all parts quoted. Upon request, Supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of Owner's order.

b. Furnish the following spare parts:

- 1) Five of each type of input/output relay for each quantity of forty or fraction thereof provided under the Contract.
- 2) Three of each type of PLC input/output module or card used.
- 3) Two replacement power supply for each type and size provided under the Contract.
- 4) One-year supply of all expendable or consumable materials.
- 5) One per quantity of five or fraction thereof of gauges, indicators, and switches provided, complete with diaphragm seals, filled and ready to use.
- 6) One per quantity of ten or fraction thereof provided, per range of field instruments including insertion type instruments. No spares are required for inline instruments such as magnetic flow meters and flumes or venturis that include flow tubes through which flow is conveyed.
- 7) Twelve of each type and size of fuse used in instruments.

2. Software:

- a. Detailed PLC programming; HMI screens shall be provided for Engineer's approval.
- b. Submit copies of programming and configuration files developed specifically for the Project in accordance with Section 017823 - Operation and Maintenance Data.

1.05 STORAGE AND HANDLING

- A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.
- B. Comply with Section 016100 - Materials and Equipment.

PART 2 – PRODUCTS

2.01 Equipment Suppliers/ I&C Subcontractor

- A. Subject to compliance with specified requirements, equipment suppliers shall be the following:
 1. McKim & Creed
 2. Commerce Controls

3. Revere Controls
 4. Carollo Engineers
 5. Jacobs
- B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by Engineer of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.
- C. Equipment Supplier: Equipment specified under this section and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.
1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by Engineer.
 2. Direct purchase of any items in these Sections by Contractor is not in compliance with this Specification and will not be permitted.
 3. When a Service Contract is included, it shall be performed by factory-trained personnel employed by equipment supplier. Equipment supplier shall assign a qualified Engineer employed by the supplier as Project Engineer/Project Manager.
 - a. Project Engineer/Project Manager's name shall be forwarded to Contractor and Engineer within 30 days after receipt of a purchase order by equipment supplier.
 - b. Project Engineer/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project Engineer/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

2.02 SYSTEM REQUIREMENTS

A. Power Supplies:

1. Electrically powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, single-phase, 60 Hertz plus-or-minus two Hertz, power supply. If different voltage or closer regulation is required, provide suitable regulator or transformer at no additional cost to Owner.

2. Provide appropriate power supplies for field instruments requiring power source less than 115 volts. Power supplies shall be mounted in control panels or enclosures installed near associated instrument or in field panels.
3. Power supplies shall be capable of minimum of 130 percent of maximum simultaneous current draw.
4. Provide power on-off switch or air circuit breaker for each item provided under this Section that requires electric power.

B. Signal Requirements:

1. Control system shall use 4- 20 mA DC analog signals, unless otherwise shown or indicated.
2. Provide signal converters and repeaters where required. Adequately size power supplies for signal converters and repeater loads.
3. Isolate signals from ground.
4. Signals transient DC voltage shall not exceed 300 volts over one millisecond and shall not have a DC component over 300 volts.
5. Discrete signals shall use 24 vdc unless indicated on drawings. Provide interposing relays where required.
6. Provide fused terminal (lighted when blown) terminal block for each digital and analog signal.

C. Surge Protection Requirements:

1. Provide surge protection to protect electronic instrumentation and control systems from surges propagating along signal and power supply cabling. Protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than instrument surge withstand level, and be maintenance-free and self-restoring.
2. Provide instruments in suitable metallic cases, properly grounded. Ground wires for surge protectors shall be connected to good earth ground and, where practical, run each ground wire individually and insulated from other wires. Mount protectors within instrument enclosure or in separate junction box compatible with the area designation coupled to the enclosure.
3. Surge suppression shall be provided on all incoming voltages, field mounted for all analog inputs, panel mounted for all analog inputs, and panel and field mounted for all Power Over Ethernet (POE) connections.
4. All surge protection shall be DIN rail mounted surge protection plug, Phoenix Contact PT and PLT or equal.

D. Miscellaneous:

1. General:

- a. Instrumentation components shall be heavy-duty types, constructed for continuous service.
 - b. System shall consist of equipment models currently in production.
 - c. Materials and equipment, including cabling and interconnections, shall be in accordance with Division 26, Electrical, and manufacturer's recommendations, unless indicated otherwise in the Contract Documents.
 - d. Materials and equipment shall, where applicable, be in accordance with UL standards and be so marked and labeled.
2. Logic and control loops shall be fail-safe. Instrumentation components shall return automatically to accurate measurement within 15 seconds upon restoration of power after power failure and when transferred to standby power supply.
 3. Provide surge protection for instruments and other control system components that could be damaged by electrical surges. Provide lightning arresters on both ends of communication lines, except for fiber optic cabling, external to buildings or structures, including leased telephone lines and similar communication lines.
 4. Field-mounted instruments and system components shall be constructed for use in humid and corrosive service conditions. Field-mounted instrument enclosures, junction boxes and appurtenances shall have NEMA rating appropriate for hazardous rating requirements shown or indicated on Electrical/ Mechanical Drawings, instrument schedules, and elsewhere in the Contract Documents.
 5. Miscellaneous hardware such as fittings, fasteners, and screws, be Type 316 stainless steel or other appropriate material to prevent galvanic reactions and shall be suitable for service intended. Piping stands shall be provided for fastening instruments as required. Provide threaded pipe stands with flange bolted to slab. Use carbon steel piping and flanges painted in accordance with Section 09 90 00, High Performance Paints and Coatings.
 6. Data processing equipment and relays with interconnections to field devices shall be wired through field wiring terminal blocks in the panel. Terminals as part of relay base are unacceptable.
 7. Arrange panel-mounted instruments, switches, and other devices ergonomically for functional use and ease of maintenance. Similar types of panel-mounted devices shall be by one same manufacturer and of the same model line.

8. Equipment furnished shall be of modular construction and be capable of field expansion through installation of plug-in circuit cards and additional cabinets as necessary.
9. Field- and panel-mounted instruments shall be tagged with equipment number and nomenclature indicated in the Contract Documents; if not so indicated, tag in accordance with approved Shop Drawings.
10. Coordinate ranges and scales specified in the Contract Documents with manufacturer of the equipment actually furnished for operability over the intended range. Complete the coordination prior to submitting Shop Drawings to Engineer.
11. Treat field-mounted devices with anti-fungus spray.
12. Protect field-mounted devices from exposure to high and freezing temperatures to provide complete operability under the environmental conditions indicated in the Contract Documents.

E. Environmental Conditions:

1. Provide control system suitable for continuous operation under the following conditions:
 - a. Indoor Instruments:
 - 1) Ambient Temperature: Zero degrees F to 120 degrees F.
 - 2) Relative Humidity: 100 percent, maximum.
 - b. Outdoor Instruments
 - 1) Ambient Temperature: 32 degrees F to 160 degrees F.
 - 2) Relative Humidity: 100 percent, maximum.
2. Protect outdoor-mounted field instruments from direct sunlight by providing sunshade for instruments. Construct sunshade out of non-corrosive material. Sunshade shall withstand wind velocity of 160 miles per hour.

2.06 IDENTIFICATION

A. Instrument Tagging

1. Headings on the field instrument schedule in the Contract Documents have the following meaning:
 - a. "TAG" is an alphanumeric character string.
 - b. "INSTRUMENT DESCRIPTION" is an explanation of instrument function.

- c. "RANGE" is the limit for the specified units of the instrument
- d. "SET POINT" is the precise value within the instrument's range.
- f. "NOTES" contains specific notes relative to the instrument.

B. Input/Output List Identification

1. I/O point list contains information required to configure PLC I/O interface hardware, and to indicate range conversion or signal functions.
2. "Tag" is an alphanumeric character string. For example, for the point "FIR-806" the following apply:
 - a. The first character is the functional identifier and conforms with ANSI/ISA S5.1. In the example, "F" represents flow.
 - b. The second and third character (and sometimes fourth and fifth) alphabetical character (I) is the function identifier. In the example, the "I" represent indication input, "R" represents recorded data.
 - c. The next three-digit number (806) identifies the loop or field device.
 - d. Suffix, where required, is used for distinguishing between similar variables.
3. "DESCRIPTION" is an alphanumeric character string up to 40 characters in length. Points described as "SPARE" indicate pre-wired I/O.
4. "TYPE" is one of the following:
 - a. AI indicates analog input.
 - b. DI indicates discrete input.
 - c. PI indicates pulse input.
 - d. AO indicates analog output.
 - e. DO indicates momentary, maintained or latched discrete output.
5. "SIGNAL" is one of the following:
 - a. ETH indicates Ethernet/IP
 - b. HARDWIRE

C. ISA Identification

1. A = Analytical.

2. B = Burner, Combustion.
3. C = Cooling (Cooling Condenser).
4. D = Dissolved.
5. E = Voltage.
6. F = Flow.
7. G = Intrusion.
8. H = Hand.
9. I = Current.
10. J = Power.
11. K = Time.
12. L = Level.
13. M = Manual.
14. N = UNDEFINED.
15. O = Overload.
16. P = Pressure.
17. Q = Communication.
18. R = Reverse.
19. S = Speed, Frequency.
20. T = Temperature.
21. U = Universal (Common).
22. V = Vibration.
23. W = Torque (Weight or Force).
24. X = Critical (Emergency).
25. Y = Event, State or Presence.
26. Z = Position, Dimension.

D. Function Identifier:

1. A = Alarm
2. B = UNDEFINED.
3. C = Control.
4. D = Differential.
5. E = Element.
6. F = Failure.
7. G = UNDEFINED.
8. H = High.
9. I = Indication.
10. J = UNDEFINED.
11. K = Factor.
12. L = Low.
13. M = Mode.
14. N = Normal.
15. O = Oxygen.
16. P = UNDEFINED.
17. Q = Quantity.
18. R = Rotation.
19. S = Switch.
20. T = Timer
21. U = UNDEFINED.
22. V = Slow (output)
23. W = Slow (input)
24. X = Selector Switch (input)

2.07 SCADA Software modifications:

- A. Products and Manufacturers: Provide the following SCADA/ HMI software:
 - 1. Proficy iFIX

Integrator is expected to match the format of the plant existing graphical screens for conformance and standardization purposes.
- B. The SCADA/ HMI Software system shall provide access to the proposed system elements that allow direct operations personnel interface to documentation, process management information, process control blocks, and system configuration elements.
- C. The software packages and subsystems shall allow operations personnel access to manipulate and monitor control blocks and operations environment. Tasks allocated to systems and process engineers and process operators shall be simplified for easy use.
- D. Software is comprised of the following:
 - 1. System configuration utilities.
 - 2. Database manager.
 - 3. Environment configuration utilities.
 - 4. Graphic screen painter.
 - 5. Graphic screen viewer.
 - 6. Historical data manager.
 - 7. Reporting system.
 - 8. Real-time data manager.
 - 9. Communications subsystem.
 - 10. Alarm handler.
 - 11. Supervisory control system.
- E. All modifications to add the proposed equipment to the System software shall work as virtually independent units or in concert with other internal software. Human interface software shall support operations such as:
 - 1. Setting up I/O database.
 - 2. Accessing I/O point settings.
 - 3. Editing graphic displays and building new displays.

4. Editing and creating objects within displays.
 5. Editing system configuration.
 6. Setting up and tracking process control trends.
 7. Checking system performance.
- F. Modifications performed to add all proposed equipment to the SCADA/ HMI software shall provide standard process control algorithms for use with control schemes as shown and specified in this Section, and to enable operations personnel to develop new supervisory and regulatory distributed digital, control schemes on-line. Provide algorithms consisting of modular, function block type of control elements which are familiar to control engineers. Algorithms shall include input blocks for acquiring, converting, and characterizing signals representing process variables; computational blocks for performing arithmetic, scaling, and compensating operations; control blocks for performing control functions; and special algorithm blocks for switching, fan-out, display, and user-specified operations, including interacting with supervisory programs. Tuning constants shall be easily set from operator consoles and workstation keyboards.
- G. Graphical user interface shall support distributed access through the alarm and historical modules as well as application development and transfer across a network with built-in network application development (NAD) functionality. NAD shall provide automatic notification of application changes and automatic distribution of updated applications to runtime (view) nodes.
- H. Graphical user interface shall be capable of exporting entire database of I/O points into CSV file format for import and subsequent editing to a Microsoft Excel spreadsheet.
- I. Electronic Documentation:
1. Documentation for control system shall be provided with the system in electronic format. Documentation shall be available and accessible from within the applications programs.
 2. Documentation shall be broken down by function. Information usually required for an authorized person to perform configuration shall be included in a guide; information required to configure the process I/O blocks shall be included in control blocks documents.
 - a. Online Help:
 - 1) Online help shall provide information and assistance to user as user uses an application program. Information available through online help shall relate to the current display, current program operation or selection, and changes as user proceeds through the program to provide user with appropriate information.

- 2) Help shall be requested by selecting "HELP" from the menu bar. Menu of topics relating to current display or selection shall appear on the screen. Help text shall be displayed in a partial screen overlay.
- 3) Screen control functions shall be displayed as menu selections.

J. Real- Time Displays:

1. Add new graphic screens using existing drawing package. Use of proprietary graphic file formats is unacceptable. The Integrator shall ensure to keep the format of the graphic screens similar to the existing graphic screens.
2. Proposed system graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, and links to other graphic screens.
3. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
4. Graphics editor shall allow layering of objects to activate specific objects based upon specific conditions in control system.
5. Graphics editor tool shall allow object placement via "snap-to-grid" feature with configurable grid spacing. The operator has the ability to configure the pixel interval on the "snap-to-grid" tool.
6. System shall support import of DXF files with the drawing elements imported as native objects. It shall be possible to animate such objects using a full set of object animation properties.
7. User shall be able to configure graphic screens while system is monitoring the process.

K. System Configuration:

1. At minimum, graphical user interface shall allow user to perform the following tasks with proper password access.
 - a. Create, delete, or edit control strategies.
 - b. Add and delete objects to the system.
 - c. Tune control loops through editing of control loop parameters.
 - d. Enable and disable control strategies.
 - e. Select points to be alarmed and define the alarm status.

- f. Select points to be trended over a period of time and initiate recording of values automatically.
- L. Integrator shall develop the new graphical screens of the proposed system and submit for Engineer/ Owner's review a draft and a final graphical screens of the proposed system that are required to be added to the existing SCADA/ HMI system.
- M. At a minimum two meetings shall be required for review of the proposed graphical screens with the Engineer/ Owner. Integrator shall accommodate/ allocate time to allow for graphical screen changes/ corrections. All changes/ corrections shall be recorded and submitted for Engineer/ Owner's approval upon which the Integrator shall coordinate for onsite deployment.
- N. Alarm Subsystem:
 - 1. Provide system with alarm window or console. Window shall notify user of alarm conditions and allow user to view details of alarm and acknowledge the alarm.
 - 2. When alarm console is not visible, separate alarm notification window will supersede other windows on the display and shall not be capable of being minimized by user. This window will notify user of new alarms and unacknowledged alarms. Alarm notification windows or banners that can be minimized by the user are unacceptable.
 - 3. User shall be able to select alarms displayed by object alarms by group and priority by using command buttons. Up to 98 priority levels shall be supported. User shall be able to view and acknowledge alarms from any node in the enterprise.
 - 4. Alarms shall be color-coded according to alarm status and priority, including an acknowledged alarm, unacknowledged alarm, and alarm that has returned to normal but is not yet acknowledged.
 - 5. System shall be configurable such that the user is notified of alarm no matter what display the user is currently viewing. Notification shall include the option of pop-up alarm display window, flashing symbol, alarm text message that is available on each display, or dedicated alarm display window on the screen.
 - 6. User shall be able to view alarms on individual or a group basis, with support for 16 groups each having up to 16 sub-groups. Alarm hierarchy shall be capable of being nested up to eight levels deep.
 - 7. Provide capability of performing alarm acknowledgment on all alarms, on alarms in a single group, and on alarms in collection of groups as defined in an alarm group hierarchy, or on a point-by-point basis.
 - 8. Provide system capable of storing alarms in structured query language (SQL) database for long term storage of alarm information.

9. Standard alarm display shall support display of the following alarm parameters which are user-selectable in the configuration mode:

- a. Date
- b. Time
- c. Event
- d. Alarm type
- e. Operator
- f. Priority
- g. Comment
- h. Tag name
- i. Group name
- j. Value of variable in alarm
- k. Alarm limit
- L. Alarm status

O. Process Report Generation:

- 1. Update existing reports to reflect processes integrated as part of this project.

2.08 SOURCE QUALITY CONTROL

A. General:

1. Factory Test:

- a. Representatives of Owner and/or Engineer will witness factory test at testing facility during operational test of equipment, either for individual units or as an integrated system. Give minimum of 30 days notice to Engineer prior to the proposed testing date so that arrangements for test witnessing can be made. Presence of Owner and Engineer during testing does not relieve Contractor from complying with the Contract Documents and shall not imply acceptance of equipment. When factory tests have been successfully completed, a submit factory test report to Engineer.

- 2. Factory test results will be acceptable when all components within tested control panel or system being tested successfully operate and meet its intended function and are so certified by the testing entity.

3. Do not ship the equipment until obtaining Engineer's acceptance of factory test results.

B. Factory Inspection:

1. Inspect each panel, console, device, and cabinet before testing and before shipping. Inspection shall include, but not be limited to the following:
 - a. Verify all "Exceptions Noted" and "Make Corrections Noted" comments on Shop Drawings were implemented.
 - b. Verify presence of and accuracy of nameplates and tags.
 - c. Verify that wire sizes and color-coding comply with the Contract Documents.
 - d. Verify presence of terminal blocks, terminal block numbers, and required quantity of spares.
 - e. Verify annunciator window engravings and quantity of spare windows comply with the Contract Documents.
 - f. Verify proper wiring practices and grounding.
 - g. Verify enclosure flatness, finish, and color.
 - h. Verify anchoring of wire bundles between subpanels and front panel-mounted devices.
 - i. Verify presence of applicable items specified in this Section.
 - j. Check and verify software licenses for latest release and license types.

C. Panel Operational Testing:

1. Test all input/output components to verify that internal panel wiring is properly terminated at correct locations. Verify initial ranges and settings.
2. Test all system hardware and software to verify proper operation as stand-alone units. Test shall include, but not be limited to, the following:
 - a. Power distribution and breaker ratings to match approved Shop Drawings.
 - b. Power fail/restart tests.
 - c. Diagnostics checks.
 - d. Demonstrate that all specified equipment functional capabilities are working properly.

- e. Check and verify process displays are in accordance with approved Shop Drawings.
- 3. Test components and devices requiring data transmission to verify that communication between such components is working properly. Verify communication by using the same media required for the completed system at the Site as indicated in the Contract Documents.
- 4. Perform integrated system test with all system equipment and simulated inputs/outputs connected to verify that equipment is performing properly as an integrated system.
- 5. Simulation devices shall be of suitable quality to not mask control panel defects.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Environmental Requirements:
 - 1. Do not install instruments in areas where construction may cause instrument to be damaged, without providing adequate protection for said instrument.
- B. Installation of Instrumentation:
 - 1. Secure field-mounted instruments to stands or brackets in accordance with manufacturer's recommendations, approved or accepted (as applicable) submittals, and the Contract Documents.
 - 2. Locate sensors where shown on the Drawings. Confirm exact locations in the field with Engineer.
 - 3. Install all devices so that devices are readily accessible for service and do not cause potential hazards.
- D. Services and Operator Instructions:
 - 1. Provide repairs or replacement of defective materials, equipment or workmanship, including with respect to equipment, the services of factory-trained servicemen.
 - 2. In addition to the calibration required for check-out, provide two additional calibrations on all instruments. The first re-calibration shall be approximately six

months after acceptance of the system, and the second shall be approximately eleven months after acceptance. As part of each calibration, provide two copies of the calibration sheets, a detailed list of deficiencies (should any be found), and a statement that the entire system is in proper operation and condition (except for the deficiencies noted) and shall be turned over to the Owner.

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections: Field Testing shall be conducted per section 406350 Field Testing. Field-verify calibration and performance of each instrument prior to start-up of the associated equipment, and document on a separate sheet for each.

1. For each calibration certification sheet, include the following information:
 - a. Project name.
 - b. Tag number and description.
 - c. Manufacturer.
 - d. Model and serial number.
 - e. Date, time and person who performed calibration.
 - f. Calibration data to include.
 - 1) Input, output, and error at 0, 25, 75, and 100 percent of span for analog instruments.
 - 2) Switch setting, contact action and deadband, if applicable, for discrete elements.
 - g. Space for comments.
 - h. Signature and date.
2. System Check-Out and Start-Up Responsibilities:
 - a. Contractor shall retain the services of the System Supplier to supervise and/or perform check-out and start-up of all system components. As part of these services, the System Supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.
 - b. Check and approve the installation of all instrumentation and control system components and all cable and wiring connections between the

various system components prior to placing the various processes and equipment into operation.

- c. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in the Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
- d. Contractor shall provide all test equipment necessary to perform the testing during system checkout and start-up.
- e. Contractor and System Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustments or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended at no additional cost to the Owner. These changes or adjustments shall be documented by the Contractor and submitted to the Engineer as part of the Installation Inspection Report described in Paragraph g. below.
- f. Contractor shall furnish to the Engineer certified calibration reports for field instruments and panel mounted devices specified in this Section as soon as calibration is completed.
- g. Contractor shall furnish Engineer an Installation Inspection Report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both Contractor and the System Supplier.
- h. Instrumentation and Control System Field Test:
 - 1) Following the instrumentation and control system checkout and initial operation, Contractor, under the supervision of the System Supplier, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended instrumentation and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by Contractor and then retested to demonstrate proper operation.
 - 2) Following demonstration of all system functions, the instrumentation and control system, including field sensors/transducers and instruments, and telemetry system shall be running and fully operational for a continuous 48 hour period.

3.04 MANUFACTURER'S SERVICES

A. General:

1. Contractor shall retain the services of the System Supplier to provide operation and maintenance training for all instrumentation and control system equipment as specified herein.
2. For equipment items not manufactured by the System Supplier, he shall provide for on-Site training by an authorized representative of the equipment manufacturer as part of his services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
3. Contractor shall be responsible for all costs associated with training and shall provide all required materials, texts and required supplies.
4. Training shall conform to the requirements of Section 017823, Operating and Maintenance Data.

B. On-Site Training:

1. General:

- a. Provide on-Site operation and maintenance training by System Supplier and the equipment manufacturer representatives prior to placing the equipment in continuous operation.
- b. Training courses shall include time for students to develop and demonstrate understanding of training concepts. Testing shall include hands on training with equipment.
- c. At the conclusion of each course students shall be tested on course material. Testing shall include exercises where students must demonstrate proper response to normal operational needs, emergencies and maintenance tasks. Every student shall be tested individually.
- d. Training shall be over a two (2) day period (i.e. Tuesday and Thursday afternoon) to include all of the operations and maintenance personnel.
- e. Training shall accomplish the following:
 - 1) Provide instruction covering use and operation of the equipment to perform the intended functions.
 - 2) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.

- 3) Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.
 - 4) Provide classes and field training as to how to change process control and alarm set points in all microprocessor based controllers and transmitters. Maintenance personnel shall be trained to enter passwords, programming or configuration data, etc.
2. Primary Sensors/Transducers and Field Instruments:
 - a. The services of equipment manufacturer's representatives shall be provided for a minimum of 2 hours for each type of instrument.
 - b. Training shall include:
 - 1) Basic repair and maintenance capabilities of installed equipment.
 - 2) Procedures for placing the equipment in and out of operation.
 - 3) Use of any special repair equipment or software packages that are used for repair or maintenance.
 - 4) Procedures for testing any repair before placing equipment back in service.
3. PLC and SCADA Training
 - a. Training shall include
 - 1) Hardware and software configuration of PLC and SCADA programs.
 - 2) Perform a walk through with students identifying system components. Instructor shall test each student's knowledge of system components during walk through.
 - 3) Identify key operating and alarm features of the project specific PLC and HMI programs.
 - 4) Test students knowledge of proper response to alarms, capabilities to replace hardware components, switch hardware and software between online and offline, add new components, know when to call for assistance, demonstrate understanding of hardware and safety requirements, understand impact of changes made to rest of the control system.

- 5) Provide instruction covering basic editing of PLC programs and SCADA screens. Instruction shall include testing students programming capabilities by having students make minor changes to programs and test changes online.

END OF SECTION

SECTION 406120

CONTROL PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Custom built control panel requirements and materials.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Division 1, Shop Drawings covering the items included under this Section.
- B. Contract Closeout: Submit in accordance with Division 1.
- C. Fabricated and pre-engineered panels are subject to this specification and Appendix A Collier County Public Utilities Division SCADA Standards Section 1.7.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Codes, Ordinances, and Industrial Standards: Design, testing, assembly, and methods of installation for materials, electrical equipment, and accessories proposed under this Section shall conform to National Electric Code and to applicable State and local requirements.
 - 2. UL listing and labeling of custom-built panels (UL 508) shall be adhered to under this Contract.
 - 3. Panels to be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.
 - 4. Panels to be located in hazardous (classified) environments shall comply with UL 698A, and bear a label stating such, and UL 2062. Panels that include intrinsically safe circuits shall comply with UL698A and shall include label stating such.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Control panels shall be manufactured in a UL listed panel shop.

2.02 CONTROL PANELS

A. Sheet Metal Construction:

1. Indoor panels located in dry and non-corrosive environments shall be NEMA 12. Outdoor panels and panels located in wet environments shall be NEMA 4X 316 stainless steel powder coated white.
2. Panel bodies shall be 12 gauge minimum for freestanding panels up to 42 inches in width, and 10 gauge minimum for panels exceeding 42 inches in width. Panel bodies shall be 14 gauge minimum for non-freestanding panels up to 42 inches in width, and 12 gauge minimum for panels exceeding 42 inches in width. Stiffening members shall be provided for strength and stiffness as required.
3. Panel subplate shall be mounted on collar studs for easy removal. Print pockets shall be provided on each panel. Brackets welded to inside of panel, complete with lights, shall be provided on panels where indicated by Drawings.
4. Wall mounted panels shall not exceed 18 inches in depth.

B. Access:

1. Wall- and/or floor-mounted control panels shall have continuous piano-hinged doors for ease of access. Door openings shall expose a minimum of 80 percent of panel interior. Door openings shall be sealed with a 0.125-inch thick minimum cellular neoprene gasket cemented with oil-resistant adhesive and held in place with a retaining strip. Print pockets shall be provided on each door. Two door enclosures shall have a removable center post. Panel doors less than 40 inches high shall be equipped with a 2-point latching mechanism. Panel doors 40 inches high or more shall be equipped with a 3-point latching mechanism.
2. Components and terminals shall be accessible without removing another component except covers. Swing out sections shall be used if mounting space is required that is not normally accessible.

C. Finish:

1. Panel face openings for mounting equipment shall be smoothly finished cut with counterboring and trim strips provided as required to give a neat finished appearance. Bezels shall be used on all front panel-mounted devices to cover panel cutouts. A chrome-plated or stainless steel bezel shall be used at parting line of panels that have shipping splits or at parting line of panels placed end to end.
2. Graphic plates, when used, shall be fastened to panel frame with fasteners not visible from front of graphic.

D. Control of Environment:

1. Provide 120 vac thermostatically controlled fan-driven heater units to maintain stable temperature within enclosure to protect equipment from harmful effects of condensation, corrosion, and low temperatures inside panels.
2. Provide automatically controlled closed-loop heat exchangers or closed-loop air conditioners to maintain temperature inside each enclosure at optimum operating temperature rating of components inside the enclosure.
3. Each heat exchanger or air conditioner shall have a dedicated, properly-sized and -rated circuit breaker.
4. Submit supporting calculations as part of panel Shop Drawing submittal if panel equipment to comply with specified environmental requirements is proposed to be deleted as unnecessary.

E. Electrical:

1. Provide in the panel, near where incoming power is terminated, nameplate with panel power supply source, type, voltage, and circuit number.
2. Protect incoming 120 vac power feeds to power the panel by providing lightning and surge arrestors, properly connected to grounds.
3. Provide panels with internal 120 vac power distribution system with properly-sized and -rated circuit breakers to distribute power. Power not more than six devices from a single breaker. When power supplies are included in the panel, not more than two power supplies shall be powered from a single breaker. Convenience receptacles and interior panel lights shall have their own breakers. When one or more field instruments require 120 vac power from the panel for instrument power, power not more than three instruments from a given breaker.
4. Provide space for a minimum of two spare breakers in each panel.
5. Internal panel wiring shall be:
 - a. AC power wiring size for current to be carried but not less than 18 AWG MTW.
 - b. Signal wiring use wiring size for current to be carried but not less than 18 AWG, 90°C MTW
 - c. Analog signal wiring use shield twisted pair 18 AWG minimum.
 - d. For wiring carrying more than 15 amps use sizes required by the NEC.
6. All panel wiring not run in wire ducts shall be bundled and tied. Each wire shall be identified at both ends with same exclusive number. Number shall be same number shown on control schematic. Number shall not be used again for any

other purpose. Wires marked differently on each end will not be accepted. Wire markers shall be provided on end of each wire at termination point.

7. Control wire coloring:
 - a. Black – 120 VAC
 - b. Red – 120 VAC Controlled
 - c. Yellow – 120 VAC Power from external devices
 - d. White – 120 VAC Neutral
 - e. Blue – 24 VDC Positive and 24 VDC Controlled
 - f. Blue w/ White Stripe – 24 VDC Ground
 - g. Green – Signal Ground
 - h. Yellow on Green – Panel Ground
 - i. Red – 4-20mA Positive Signal Wiring
 - j. Black – 4-20mA Ground
8. Provide an instrument common bus 0.1 by 0.5 by 6-inch minimum in enclosure and isolated from enclosure. A separate instrument common wire shall be run from each common terminal on an instrument to instrument common bus. Instrument common wires looped from one terminal to another and then to instrument common bus will not be accepted.
9. Instrument common bus shall be connected to power supply common with a wire or wire braid strap as short as practical and of sufficient capacity to prevent troublesome voltage drop. Common terminals and common bus for instrument common shall be tagged "Instrument Common." Instrument signal wires of 4-20 mA or 1-5V shall be shielded wire. Telephone wires and telemetry equipment interconnection wires shall be shielded wires.
10. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosures are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
11. Wires to internal components shall be connected to inside of terminal strip. Wires to external components shall be connected to outside of terminal strip. No more than 2 wires shall be connected to one terminal point.

12. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of 1-inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of nonmetallic materials with voltage insulation in excess of maximum voltage carried therein.
13. Vendor provided control panels and consoles with motor controllers, such as motor starters and/or VFDs, shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Single phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
14. Disconnect shall have enclosed protected terminations to prevent accidental shock.
15. Relays, timers, etc., installed on panel subplate shall be provided with a minimum spacing between component and wire duct of 1.5 inches above and 1 inch below. Minimum spacing between adjacent components shall be 0.25 inch. Relays, timers, etc., shown in schematics are intended to show function. Additional relays may be required in conjunction with items shown to provide total number of contacts required. Where limit, pressure, float switches, etc., are used and more than SPDT contacts are indicated by schematics, provide additional contacts required by using auxiliary relays. However, if a DPDT switch is called for, using a SPDT with a relay will not be accepted. All control and pilot devices such as relays, timers, etc., shall be 120V, 3 amp rated except where noted with 24VDC coil voltage. One N.O. spare contact shall be provided on each relay.
16. Inside of panels, route dc signal wiring separately from power wiring with minimum separation distance of six inches.
17. Use covered wireways to route internal panel cables and wiring. Wireways in each section of panel shall be appropriately sized to accommodate the quantity of wires to be routed with a spare capacity of 40 percent.
18. Install wire troughs inside panels along horizontal or vertical routes to present a neat appearance. Angled runs are unacceptable.
19. Wiring that is routed without wireways shall be adequately supported and restrained to prevent sagging or other movement. Use of adhesive anchors to support or restrain wiring is unacceptable.
20. Terminate internal panel wiring using forked, insulated, crimp-on connectors; soldered connectors are unacceptable. Provide panels with 600-volt rated barrier type terminal strips mounted on Din rails. Identify terminal strips as indicated in this Section. Identification devices shall be self-stick, plastic tape strips with permanent, machine-printed numbers.

21. Wiring in panels shall be installed such that, if wires are removed from any one device, power will not be disrupted to other devices.
22. Provide spare terminals equal in number to 20 percent of terminals used for each type of wiring (e.g., dc signal and ac power).
23. Provide ground terminals to terminate the shield wire of shielded cables. Termination of more than two shielded wires on a single ground terminal is unacceptable.
24. Provide a single copper bus bar with 5/16 inch diameter copper grounding stud to connect the panel to external ground. Panel's internal grounds shall be terminated to the bus bar.
25. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
26. When dc power is required, furnish and install in the panel required power supplies.

F. Panel/Subplate Layout:

1. Panel face-mounted equipment shall consist of pilot lights, push-buttons, selector switches, meters, indicating timer, etc. Spacing between horizontal rows of components shall be 1.5 inches minimum; spacing between vertical columns of components shall be 1.875 inches minimum. Components shall be grouped and/or located as indicated on Drawings. Distance from bottom row of components to floor shall be not less than 36 inches. Top row of recording and indicating instruments shall be centered approximately 60 inches above floor. Maximum height for annunciator windows shall be 85 inches above floor. In general, indicating lights, push-buttons, etc., shall be mounted in accordance with sequence of operation from left to right and top to bottom.
2. A minimum of 2 inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on vertical edges of subplate. Where terminal strips are mounted side-by-side, terminals shall be elevated 1.5 inches above subplate to allow wires to pass underneath.
3. Subplates shall have a minimum of 15 percent spare mounting space, and terminal strips shall have a minimum of 20 percent spare terminal blocks.

G. Control Panel Accessories:

1. One 120 vac, 15-amp duplex, GFCI duplex receptacle.
2. One 120 vac LED service light fixture with protective plastic shield for every 4 feet of panel width.

3. One 120 vac snap switch, to turn on service light, mounted in outlet box with cover and located so that switch is easily accessible from access door.
4. Service light with switch and duplex receptacle shall have a dedicated circuit breaker.
5. Provide complete wiring diagram of “as-built” circuitry enclosed in transparent plastic.
6. One folding laptop shelf on inside of door, shelf shall be welded to door to avoid any rating changes to enclosure.

H. Identification:

1. Identification plates shall be laminated phenolic with black letters engraved on a white background and mounted with screws or double-back adhesive foam tape.
2. All components inside panel shall have identification plates. This includes instruments, relays, switches, circuit boards in plug-in racks, etc. Identification plates shall include engineering symbols (FBQ-1, SW-3, FIC-4, CR-1, etc.). Switches and circuit breakers inside panel shall have names (Horn, Audio Tone, Panel Power, etc.) on identification plates as well as engineering symbol.
3. Identification plates shall be located on or adjacent to device they are identifying and shall be readable without looking around, under, or on top of device to find identification plate.

2.03 SWITCH, PUSH BUTTONS, LIGHTS

- A. Selector switches shall be 120 VAC rated, oil-tight construction with standard operator knob.
- B. Start push buttons shall be 120 VAC rated, oil-tight construction with extended guard and black color insert.
- C. Stop push-buttons shall have a half-guard with black color insert. Contacts shall be rated NEMA B-150 and P-150.
- D. Pilot lights shall be push-to-test oil-tight construction, LED with cap colors and voltages as required. Nameplates for each switch and light shall conform to manufacturer's series and type with engraving as called for on Drawings.

2.04 RELAYS

- A. Control Relays: Switching and output relays shall be plug-in type with contacts rated 120 VAC, 3 amp with 24 VDC coil, indicating light, manual operator, and plastic transparent cover. Relays shall have a retainer mechanism to prevent loosening from vibration. Relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.

2.05 TERMINAL BLOCKS

- A. Terminal blocks shall be 300 or 600 volt rated, channel-mounted box lug with pressure plate type or binding head screw type with pressure plate, and shall have a white marking strip. Terminal blocks shall be color-coded according to the following coloring scheme:

Gray Typical.

Green and Yellow Ground terminal blocks.

- B. For terminals associated with 120V nonisolated input cards, individually fused terminal blocks shall be used for 120V power to field devices.
- C. Provide a minimum of 20 percent spare terminals for each type and color of terminal used. All terminals of a given color shall be grouped with other terminals of the same color.

2.06 SURGE PROTECTION DEVICES

- A. 120 VAC Surge protection shall be Phoenix Contact VAL or equal.
- B. 24 VDC Surge protection shall be Phoenix Contact PT or equal.
- C. Ethernet surge protection shall be Phoenix Contact DT-LAN or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 406113.

END OF SECTION

SECTION 406123

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section project specific PLC and I/O model numbers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 013323 and 406113, Submittal Procedures covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. All control panels requiring PLC's:
 - a. Allen-Bradley CompactLogix 1769.
 - b. For specific CPU and I/O module part numbers refer to Appendix A – Collier County Public Utilities Division SCADA Standard Section 1.5 PLC – Allen Bradley.

2.02 PLC PROGRAM

- A. PLC programming shall be in ladder logic form.
- B. Provide all PLC programs with notes to Client on USB storage device once project as reached final completion.

PART 3 - EXECUTION

None

END OF SECTION

SECTION 406166

SOFTWARE SERVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, equipment, and services necessary for furnishing fabrication, production, and installation of items specified in this Section or as shown on Drawings.
- B. Work includes programming, testing, and installation of software required for a complete and fully operational control system. Principal segments of Work include, but are not limited to, programmable logic controller ladder logic, data collection, operator process control interfaces.
- C. The SYSTEM SUPPLIER shall integrate the new PLC's located on the drawings into the new SCADA system.
- D. The SYSTEM SUPPLIER shall provide ALL graphic screen and report development associated with all plant treatment processes.
- E. The SYSTEM SUPPLIER may duplicate software logic code and database and graphics applications, as required, while still meeting the functional specifications. The Engineer may require modifications to the submitted graphics, reports and control logic without change to the contract price. All engineering development required by the SYSTEM SUPPLIER will be in accordance with the Conditions of this Contract.

1.02 SYSTEM DESCRIPTION

- A. Performance Requirements: Programmable logic controllers (PLCs) shall complete execution of all rungs with a cycle time not to exceed 250 mS. HMI functions shall have a 2-second response time or better. Adjust timing and operating system parameters of PLCs and computers as necessary.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 013323 and 406113, Submittal Procedures and product data for products provided under this Section.
- B. An application programming design package that contains a written description of each control strategy. These descriptions shall lead the user through the major subsections of the programs. They shall generally describe the programming methods and techniques that will be used to implement the functional requirements of this Specification.
- C. A graphic screen development package that includes:

1. A list of all proposed screens.
 2. Proposed color standards that would subsequently be used to develop the screens.
- D. A final documentation package that includes:
1. Licenses in the Owner's name for all software supplied.
 2. Final copies of all programming files on USB drive, including:
 - a. PLC programs.
 - b. Radio configuration files.
 3. A complete printout of all PLC program logic with notes.

1.04 QUALITY ASSURANCE

- A. Project progress meetings shall be held at Site at an interval not to exceed once per month during the software development cycle. Meetings shall be once per week during software installation and field checking phases. Representatives of Owner and Engineer will attend these meetings.

PART 2 - PRODUCTS

2.01 SERVICE SUPPLIER

- A. Software services shall be fulfilled by the organization selected as "Equipment Supplier" under Section 406113.

2.02 SOFTWARE SERVICES

- A. Software services include program development, testing, documentation, and Work necessary to implement a complete and fully operating system as shown on Drawings and/or as specified. Provide programming to implement required functions and features.
- B. Work requires coordination with concurrent program development for PLCs, Operator Interfaces. Include PLC error detection logic for communications failures, data highway faults, internal faults, and time outs. Communicate PLC error conditions to Operator Interface for logging and reporting.
- C. Communication between PLCs and Operator Interface shall be on an exception basis. When reportable changes in process state occur, such as alarm assertion, return to normal, or analog value out of dead band, report event to PLC that communicates with Operator Interface. This PLC shall maintain data tables current with all process inputs and outputs. Organize data to be transferred into contiguous blocks of information using bit-mapped and integer tables. Employ a "watchdog" timer for each remote PLC

and poll that PLC if no message has been received in a reasonable amount of time. Accept Operator Interface directives for setpoint changes and hand switches.

- D. PLC Software. The latest revision of the programming software shall be installed as of substantial completion. This shall include software for programming the PLCs as well as Windows based software for configuring the local operator interface applications. Provide a full copy of both packages on the HMI subsystem as well as on the programming laptop specified elsewhere herein.

1. PLC programming software: Rockwell Automation RSLogix 5000 or Studio 5000.
2. HMI programming software: FactoryTalk View Studio
3. SCADA programming software: Proficy iFIX

2.03 PROGRAMMABLE CONTROLLER LOGIC

- A. Develop programs for execution on PLC using development software supplied under that Section. Logic shall perform functions required to control processes and equipment as shown on Drawings and/or as specified. Develop complete cross-references for ladder logic and complete input/output listings.

2.04 HUMAN MACHINE INTERFACE (HMI)

- A. Operator Interface programs for HMI's provide graphic representation of local processes and control over machinery.
- B. Screens shall include indicating lamps and hand switches shown. Include analog instruments such as indicators, manual loading stations, controllers, etc., as shown. Programming shall be done using panel viewing software as manufactured by the PLC vendor.
- C. Operator Displays: Develop programs to provide following elements and as required for a complete fully functional Operator Interface and data collection system:
 1. Video displays shall be color at highest resolution supported by hardware. Install operating system drivers as necessary. They shall be fully windowed. Use colors, function keys, and navigational controls consistently.
 2. Alarm Management: For each process or system event classified as an alarm provide facilities for displaying and logging on system alarm printer, acknowledgment, and purging of stale messages. Alarm events are derived from discrete inputs, analog trip values, logic combinations and computations as needed. Print and display each alarm events and returns to normal. Provide date/time stamps for events, descriptive message, and event type code. Use color combinations to distinguish following alarm states: Alarm-Unacknowledged, Alarm-Acknowledged, Normal-Unacknowledged, and Normal-Acknowledged.

3. Graphic Displays: Provide process-oriented displays showing current process status and accepting operator input for setpoint and status changes. Submit for approval color schema and screen-to-screen navigation strategies. For each display, show process elements such as pumps, valves, tanks, pipelines, etc., with their current operational status. Provide analog displays for board instruments shown including indicators, controllers, manual loading stations, etc. Indicators shall use an appropriate number of significant digits and dead band to produce steady values and color to show operational status.
 4. Trending: Provide on-screen trending displays that are user definable that operate from either previously collected historical trend groups (named file) or from a group of real-time variables. Provide facilities for user selection of colors, time (horizontal), and measurement (vertical) scales. Accommodate real-time sampling intervals as short as 1 second. Real-time trends shall show alarm setpoints. Historical trend displays shall have timescale panning controls.
 5. Security: Using operator interface and operating system software, implement a security system to restrict access to parts of system. Provide following as a minimum:
 - a. Programmer- Access to all facilities including changing displays and logic.
 - b. Supervisor- Access to all displays, change master set points and purge stale alarm messages.
 - c. Operator- Access to all displays, change normal operational sequences and acknowledge alarms.
 - d. Observer- Access to displays only.
- D. Provide following data management functions:
1. Collection files are closed at 00:05 of first day of each calendar month and a new file started. Establish a file naming convention based on file type (analog, historical, or motor), month, and year. Provide operator screens for managing file space:
 - a. Backing up to archive medium.
 - b. Restoration from archive.
 - c. Deleting archive files.
 - d. Display/print of archive catalog.
 - e. Forcing early closure of collection file.
 - f. Create export file.

2. Analog Points: Scan each analog point every minute. Every hour, store minimum, maximum, and average values in a journal file. Do not store values that are out of range, out of service, or not valid for any other reason.
3. Historical Trend Data Collection: Establish data collection tables for up to 20 groups of up to 6 process points each with a collection interval of 1 minute. Provide facilities for defining and changing trend groups. Removal and archiving of closed trend files shall be accomplished using operating system's standard backup/restore programs. Do not store values that are out of range, out of service, or not valid for any other reason.
4. Motor Run Times: For each monitored motor, store daily values for running time. Run times may be developed either by scanning points every minute or by providing PLC timer logic. Daily accumulated run times are to be stored at 00:01 of each day and then reset. Close running time data collection file at 00:05 on first day of each month.
5. Data Export: Provide collected data file export facilities for use by management reporting programs and third-party data analysis programs such as dBase IV and spreadsheets. Export files shall be ASCII encoded, fixed record (and field) length with carriage control. Export files shall be made from closed collection files on user demand.

2.05 OPERATOR INTERFACE AND DATA COLLECTION (SCADA)

- A. This section defines requirements for modifications to the Owner's existing SCADA system operator interface (located at City of Rockledge WRF) and the new operator interface units located at the new Flow Equalization Basin & Sludge Thickening and Digesters Rehabilitation control panels, to incorporate the Flow Equalization System and Sludge Thickening and Digesters Rehabilitation Processes. Existing displays may be copied and modified as necessary.
- B. The standards to be used for new graphic screens and specific details of report formats and contents shall be defined by Owner and Engineer at the first project meeting.
- C. Provide a new graphic screen that provides an overview of the plant process similar to the process diagram contained in the Contract Drawings and including, as a minimum, the following
 1. Instantaneous and accumulated daily totals for influent and effluent flows.
 2. Depth and volume of fluid in the equalization basins and digesters.
 3. For individual EQB transfer pumps, jet air mixing/aspiration pumps, WAS pumps, and blowers:
 - a. Status: Running/stopped, in alarm, remotely controllable, in automatic (software switch).

- b. Speed.
 - c. Link to detailed equipment control screen.
 - 4. For individual control valves:
 - a. Status: Open/closed/position, in alarm, remotely controllable, in automatic (software switch).
 - b. Link to detailed equipment control screen.
 - 5. For individual polymer metering pump:
 - a. Status: Running/stopped, in alarm, remotely controllable, in automatic (software switch).
 - b. Speed.
 - c. Link to detailed equipment control screen.
 - 6. For individual gravity belt thickeners (GBT):
 - a. Status: ready status, in alarm, running.
 - b. Link to detailed equipment control screen.
- D. Provide additional new graphic screens for the following:
 - 1. Equipment Screens - These should be individual equipment screens that provide complete details of each control valve, high service pump, blower, GBT, polymer metering pump, and digester.
 - 2. Diagnostic Display - This should identify communication link throughput and Bit Error Rates, PLC low battery, PLC running, PLC module faults, etc. The display should “look” like the actual equipment by showing individual modules in the correct location within the rack. Colors will then designate the specific module that is failed.
- E. Modify existing system diagnostic displays to incorporate the new RTU.

2.06 CONTROL STRATEGIES – COMMON REQUIREMENTS

- A. General Requirements applicable to Section 13470 Process Control Narrative are:
 - 1. All software fault conditions that are set can only be cleared by operator acknowledgement.
 - 2. When commands are issued from the HMI/SCADA, latch the commands in the PLC such that if communications are lost between the HMI/SCADA the command value is retained in the PLC.

3. All control strategies shall run within the PLC. Data manipulation (calculated analog values, elapsed time functions, event determination) shall be performed by the PLC for the associated equipment it is monitoring. Any resulting values from these manipulations shall be reported as individual registers. The intent is to avoid utilizing the HMI software for this purpose.
 4. The control functions described herein and in Section 13470 Process Control Narrative are not intended to be complete comprehensive programming logic descriptions. They depict only the general intended control operation required. Provide complete program logic to completely fulfill the functional requirements indicated.
 5. Provide all programming necessary to support the functional requirements of the operator graphic screens.
 6. Provide complete debugging services to address issues identified by the Owner or Engineer during and after startup until final acceptance.
- B. Except where specifically defined elsewhere in Section 13470 Process Control Narrative provide the following for analog inputs (pseudo and real):
1. For all analog inputs:
 - a. Provide out of range alarms if the input signal goes outside the instrument's range.
 - b. Provide individually adjustable emergency high and low alarms when the value goes outside the allowable process range.
 - c. Provide individually adjustable high and low alarms when the value goes outside the normal process operating range.
 - d. Provide individually adjustable alarms to indicate when a process variable changes value at an abnormal rate.
 - e. Provide a dead band on all alarm settings.
 - f. Issue Return-to Normal alarms whenever the signal returns to within limits.
 2. For all flow related analog inputs:
 - a. Monitor for and record minimum and maximum daily values. Record the date and time of occurrence for each.
 - b. Accumulate a running daily total flow. At midnight, transfer the total to yesterday's total and restart from zero.

- c. Calculate a running daily average flow. At midnight, transfer the value to yesterday's average and restart the averaging.
 - 3. For all level and pressure related analog inputs:
 - a. Monitor for and record minimum and maximum daily values. Record the date and time of occurrence for each.
- C. Except where specifically defined elsewhere in Section 13470 Process Control Narrative provide the following for discrete inputs (pseudo and real):
 - 1. For all discrete inputs:
 - a. Indicate but do not alarm when a discrete signal changes, as expected, as a result of a control command.
 - b. Alarm when a discrete signal fails to change within a preset time, adjustable on an individual point basis, after a control command. Set a software fault for the controlled device that can only be reset by operator action.
 - 2. For all local control switch position feedback discrete inputs:
 - a. Issue an advisory alarm to the operator whenever a position change is detected
 - b. Exclude from any control strategy any equipment whose local switch position precludes control. If an operator attempts to control the device through the system, issue a message indicating that the control cannot be accomplished together with the reason.
 - 3. For all motorized equipment:
 - a. Accumulate equipment run times based on the running status feedback discrete input.
 - b. Reset the run time value to zero only on operator command
 - 4. For all device failure discrete inputs:
 - a. Issue an alarm when the input indicates a device fault
 - b. Set a software fault for the controlled device that can only be reset by operator action after the fail signal has been removed.
- 5. Provide Derivative, Integral, Proportional adjustable parameters for all PID loops.

PART 3 - EXECUTION

3.01 SOURCE QUALITY CONTROL

- A. Conduct preliminary testing prior to factory checkout by executing programs supplied for this Project. Use simulated input and output devices as necessary to verify correct interpretation. Exercise inputs to test logic for correct function and proper response of outputs. Verify correct interface of PLC logic with programs used for Operator Interface and Data Collection Activities.
- B. Following successful completion of the factory demonstration test, and each time any change is made thereafter, make a complete copy of all application programs and screens on USB drive. Keep these discs until final acceptance.
- C. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410 Basic Instrumentation Requirements.

3.02 OWNER TRAINING

- A. Operations: Provide a minimum of two days of initial training at the jobsite for up to six of the Owner's personnel in the operation of the system. Provide a third day for follow up training. The training shall cover at least the following subjects:
 - 1. System overview covering basic system design, configuration and purpose.
 - 2. Use of the new graphic screens.
 - 3. Explanation of the control strategies running in the PLC. The intent shall be to make the student fully knowledgeable in all aspects of the system provided, along with methods for making additions, modifications, and deletions to the system.

END OF SECTION

SECTION 406350

FIELD TESTING

PART 1 - GENERAL

1.01 SUMMARY

- A. This section describes the requirements for field-testing equipment supplied under Sections 406113 Basic Instrumentation Requirements, 406310 Process Control Narrative, 406166 Software Services, and 406123 Programmable Logic Controllers and demonstrating the complete integration of the work.
- B. Furnish test equipment required to perform the testing specified herein. This test equipment may either be owned or leased and is not a part of the equipment furnished to the Owner under this Contract.
- C. Pretest equipment and wiring before beginning any formal field tests. Document pretest results.

1.02 SUBMITTALS

- A. Include test procedures, coordination/scheduling issues, and sign-off forms for each of the following tests:
 - 1. Loop Tests.
 - 2. Control Loop Tuning.
 - 3. Function Tests.
 - 4. Control Strategy Tests.
 - 5. Integrated System Tests.
- B. With initial test procedure submittal, include a proposed schedule outline which indicates how tests will be scheduled within specific subsystems or type, how coordination issues for each subsystem or type of test affect the proposed schedule, duration of tests, and any constraints between tasks or tests. Include time for mobilization of test personnel, set-up for each type of test or subsystem as applicable, and coordination meetings with construction manager. Include a written description or list of all field wiring required to be terminated and labeled for each subsystem or type of tests including whether panel end, equipment end, or both is required to be terminated and labeled before test.
- C. After testing, submit the completed test sign-off forms within ten days.

- D. Document loop checks on the loop drawings and submit to the Engineer. Include the following:
1. Type of test(s) performed.
 2. Date tested.
 3. Problem description, if any.
 4. Signature of tester and date.
 5. Signature of Engineer and date.
 6. Attach additional sheets to the loop drawings as needed to document resolution of issues raised during the test.
- E. Submit loop tuning documentation to the Engineer which includes:
1. Loop number and description.
 2. Problem description, if any.
 3. Signature of tester and date.
 4. Signature of Engineer and date.
- F. Document strategy tests and submit to the Engineer. Include the following:
1. Strategy identification.
 2. Tests performed.
 3. Logic which could not be tested.
 4. Copies of messages, displays, and trends which verify operation.
 5. Problem description, if any.
 6. Signature of tester and date.
 7. Signature of Engineer and date.
- G. Document function tests and submit to the Engineer. Include the following:
1. Description of function.
 2. Tests performed.
 3. Copies of messages, displays, reports, and trends which verify operation.

4. Problem description, if any.
 5. Signature of tester and date.
 6. Signature of Engineer and date.
- H. Submit separately test results which indicate failure and need to be retested. Indicate reason for failure, proposed date for retesting, and overall schedule impacts if any.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. Pretest loops and wiring prior to formal field testing. Provide complete documentation describing results of pre-testing. Clearly indicate that loops have been pre-tested, along with descriptions of any problems encountered. Perform no formal field testing until pre-tests have been completed.
- B. Conduct field tests in the presence of the Owner or Engineer, except when advised by the Engineer that test witness presence will not be necessary.
- C. If a test, or a portion of a test, fails to the point where it needs to be rescheduled for a later date, re-testing shall be required at no additional cost to the Owner and no extension of the Contract completion date.
- D. Perform field testing to verify the operation of the control system. Perform field testing sequentially and organize by plant area and by unit process within each area. Field tests are as follows:
 1. Loop tests.
 2. Loop tuning.
 3. Control strategy tests.
 4. Function tests.
 5. Integrated system test.
- E. Test each major subsystem. A subsystem is an integrated, fully operational subset of the control system and includes the following:
 1. Programmable Logic Controller (PLC) and associated I/O.
 2. Network communications equipment required for operation of the subsystem.

3. Field instruments, panels, termination cabinets, control devices and related interconnections provided for the plant area.
 4. Operator interface and graphics added and integrated into the existing Plant Control System.
- F. Meet the following conditions prior to the start of any testing:
1. Correct deficiencies noted during unwitnessed in-factory testing.
 2. Have documentation on-site pertinent to the part of the system being tested.
 3. Have on-site, labeled, and properly stored, spare parts, expendables and test equipment pertinent to the part of the system being tested.
 4. Have Engineer approved test schedules and test procedures.
- G. Schedule field testing through the Construction Manager and the Owner on a daily basis.
1. The Owner may redirect testing from one-unit process to another. Make no claim for delay or additional costs for testing if the testing effort is redirected to a different unit process provided the following conditions are met:
 - a. The redirection does not cause more than one-hour interruption to the testing to move test equipment and test personnel to the new unit process.
 - b. There is no change in the amount of test equipment or personnel requirements.
 - c. The redirection is not arbitrary. Process operational constraints, personnel availability, and other's work are valid reasons for redirection.
 - d. The redirection does not occur more than once in any workday subsequent to the daily scheduling meeting.
 2. Perform no testing that may affect plant operation without Owner concurrence.
 3. Perform testing on a per site basis. Test no more than one site at any given time.
- H. Perform tests by following the operation and maintenance manuals word-for-word unless approved otherwise by the Engineer. Lack of complete, detailed manuals will be cause for declaring the test to have failed regardless of the actual test results.

- I. Begin testing by performing the following steps:
 - 1. Check equipment against shop drawing lists.
 - 2. Verify that the equipment has been installed in accordance with Contract documents and manufacturer's directions.
 - 3. Power up the equipment and run diagnostics to verify error-free operation.
 - 4. Load software.
- J. Make available for Owner's use loops and control strategies that have been verified to operate properly immediately subsequent to conclusion of the respective test.
- K. The Owner and/or Engineer may participate in testing activities at the Owner's discretion.
 - 1. This participation will serve as a learning experience for plant operations and maintenance personnel but does not take the place of specified training.
 - 2. This participation does not relieve the Contractor from the specified requirements for testing.
 - 3. Recognize and adjust for Owner involvement in developing test procedures and schedules.
 - 4. Owner participation and use will be such that it does not adversely affect specified testing requirements. Make no claim for delay unless the following conditions are met:
 - a. The Owner and the Engineer are notified verbally that Owner actions could cause delay if continued.
 - b. The Owner persists in the delay action.
 - c. Submit written documentation within 24-hours which describes the Owner action and the impact.

3.02 LOOP TESTS

- A. Verify field wiring continuity from field device to PLC Panel termination.
- B. Check each loop from the end element to the respective Operator Workstation control display. Include instruments, field wiring, control devices, panels, termination cabinets, input/output cards and other devices in the loop to ensure proper operation and linkage to control station displays.
- C. Test operation of the final control element through panels and through control stations. If a final control element is out of service or not released by the Owner for testing, simulate operation at the final control element location.

- D. For loops found to contain defective or inoperable equipment perform the following:
 - 1. Correct and recheck these loops when equipment is operable.
 - 2. The Engineer will assist in coordinating the correction of defective work by others.
 - 3. Do not perform additional checkout work unless directed by the Engineer.
- E. Verify scaling of all devices from minimum to maximum output/range.
- F. Document all debugging issues, fix until the operation is satisfactory, verify and obtain approval of the Engineer/ OWNER.

3.03 CONTROL LOOP TUNING TESTS

- A. Complete loop checkout and problem correction prior to loop testing.
- B. Tune regulatory control loops to produce stable control. Use a loop tuning software program to document loop performance.
 - 1. For conventional control loops for PI and PID control, use minimum ITAE (Integral of Time and Absolute Error) criteria with overshoot constrained to 10 percent unless otherwise directed by the Engineer.
 - 2. Provide reduced gains or filtering to minimize unnecessary output activity to electric actuators as directed by the Engineer.
 - 3. Adjust input scan time or time intervals between controller calculations as necessary to produce stable control.
 - 4. Tune cascaded controllers similar to the above with the inner loop tuned first while the outer loop is off or inactive.
- C. Derive initial tuning parameters from open loop tests. Make final tuning parameter adjustments based on closed loop tests.
- D. Operate tuned loops for a minimum of 24 hours prior to control strategy testing.

3.04 CONTROL STRATEGY TESTS

- A. Submit Control Strategy Test Plan for approval and use during test. Documentation shall include a sequence of all tests for each equipment individually and an overall startup and shut down operation. Upon approval of the test plan, schedule with Engineer and Owner for conducting the Control Strategy Test at site.
- B. Fully test control strategies to ensure specified operation. Include the following:
 - 1. Sequences.
 - 2. Alternate control modes.

3. Dynamic gain adjustments.
 4. Contingency responses to device failures, where possible.
 5. Display and keyboard interaction.
 6. Messages.
- C. Prior to use on the process equipment, compare strategies with approved submittals to verify that as-built linkages and logic agree with the documentation. Note and correct discrepancies.
- D. Test as much of the logic as possible for process equipment. It may not be possible to test all logic due to operational constraints.
- E. Annotate changes made during testing on the documentation to reflect final as-built conditions.

3.05 FUNCTION TESTS

- A. Test functions of subsystems to verify that the subsystem has been installed and is operational. Test functions that apply to the subsystem being tested.
- B. Fully test operator station functions. Include the following:
1. Process control displays and linkages.
 2. User entry functions.
 3. Alarm and event handling. Generate or simulate alarm conditions to test.
 4. Other specified functions for the stations.
- C. Test data handling and access functions. Use live data and include the following:
1. Plant-wide database.
 2. Historical data collection and storage, retrieval, and correction at both SCADA Servers.
 3. Historical trending.
 4. Report generation and printing.
 5. Other specified data handling functions.
- D. Demonstrate the following support and maintenance functions:
1. System status displays and use.

2. Diagnostics.
 3. Power fail/restart.
 4. Other specified functions.
- E. Data acquisition tests shall include the following:
1. Plant Control System data acquisition via the in-plant PLC fiber optic Ethernet data highway.
 2. Alarm/event handling.

3.06 INTEGRATED SYSTEM TEST

- A. The integrated system tests may only begin after other testing specified in this section has been completed and test results submitted.
- B. Perform integrated system testing to verify the operation and performance of the complete, integrated control system.
1. Begin integrated system testing after other field tests have been completed.
 2. Conduct the test for two calendar weeks, 24 hours per day.
 3. Provide full-time, on-site assistance during business days and within four hours after call-in for the test duration.
 4. The Engineer will monitor and participate in the test.
- C. Include the following:
1. Data communication, both normal and failure modes.
 2. Fully loaded system response times.
 3. Other system operations the Engineer may elect to perform.
- D. Correct deficiencies within 24 hours of notice. If deficiencies remain uncorrected at the end of the test period, the test period will be extended on a day-to-day basis until specified operation can be demonstrated.

END OF SECTION

GOLDEN GATE I/O TABLE										
NO	SHEET #	DESCRIPTION	TAG	TYPE	SIGNAL	RANGE / OFF STATUS	UNITS / ON STATUS	FIELD WIRING DATA		NOTES
								FIELD ISA SIGNAL SOURCE / DESIGNATION	CONTROL PANEL	
1										
	I-200	INFLUENT FLOW	FIR-0100	AI	ETHERNET	0-XX	GPM	FE/FIT-0100	PSCP	
		INFLUENT PRESSURE	PIR-0100	AI	HARDWIRE	X-XX	PSI	PE-PIT-0100	PSCP	
		INFLUENT FILL VALVE OPEN COMMAND	YC-0100	DO	HARDWIRE	CLOSE	OPEN	FILL VALVE CP	PSCP	
		INFLUENT FILL VALVE NOT IN REMOTE	HA-0100	DI	HARDWIRE	ALARM	IN REMOTE	FILL VALVE CP	PSCP	
		PRE TOTAL CHLORINE	AIR-0100A	AI	HARDWIRE	0-5	PPM	AE/AIT-0100A	PSCP	
		PRE PH	AIR-0100B	AI	HARDWIRE	0-14	STD	AE/AIT-0100B	PSCP	
		POTABLE WATER STORAGE TANK LEVEL	LIR-0100	AI	HARDWIRE	X-XX	FEET	LE/LIT-0100	PSCP	
		POTABLE WATER STORAGE TANK LEVEL LOW	LLA-0100	DI	HARDWIRE	NORMAL	ALARM	LE/LIT-0100	PSCP	
		POTABLE WATER STORAGE TANK LEVEL HIGH	LHA-0100	DI	HARDWIRE	NORMAL	ALARM	LE/LIT-0100	PSCP	
		POTABLE WATER STORAGE TANK LEVEL LOW LOW	LLLA-0100	DI	HARDWIRE	NORMAL	ALARM	LSLL-0100	PSCP	
		POTABLE WATER STORAGE TANK LEVEL HIGH HIGH	LHHA-0100	DI	HARDWIRE	NORMAL	ALARM	LSHH-0100	PSCP	
		GST MIXER RUN COMMAND	YC-0101	DO	HARDWIRE	START	STOP	MOTOR STARTER	PSCP	
		GST MIKER NOT IN REMOTE	HA-0101	DI	HARDWIRE	ALARM	IN REMOTE	MOTOR STARTER	PSCP	
		GST MIXER FAULT	YA-0101	DI	HARDWIRE	NORMAL	FAULT	MOTOR STARTER	PSCP	
		POTABLE WATER RECIRCULATION FLOW	FIR-0200	AI	ETHERNET	0-XX	GPM	FE/FIT-0200	PSCP	
		FREE AMMONIA	AIR-0200	AI	HARDWIRE	0-10	PPM	AE/AIT-0200	PSCP	
		3 ADDITIONAL READINGS FROM AIT-0200		AI	HARDWIRE			AE/AIT-0200	PSCP	
		RECIRCULATION PUMP NOT IN REMOTE	HA-0201	DI	HARDWIRE	ALARM	IN REMOTE	02-RCP-01 STARTER	PSCP	
		RECIRCULATION PUMP RUN COMMAND	YC-0201	DO	HARDWIRE	START	STOP	02-RCP-01 STARTER	PSCP	
		RECIRCULATION PUMP DISC POSITION	ZA-0201	DI	HARDWIRE	NORMAL	ALARM	02-RCP-01 STARTER	PSCP	
		RECIRCULATION PUMP DRIVE FAULT	YA-0201	DI	HARDWIRE	NORMAL	ALARM	02-RCP-01 STARTER	PSCP	
		RECIRCULATION PUMP RUNNING	YIR-0201	DI	HARDWIRE	RUNNING	-	02-RCP-01 STARTER	PSCP	
		RECIRCULATION PUMP HIGH MOTOR TEMPERATURE	THA-0201	DI	HARDWIRE	NORMAL	ALARM	02-RCP-01 STARTER	PSCP	
		EFFLUENT FLOW	FIR-0300	AI	ETHERNET	0-XX	GPM	FE/FIT-0300	PSCP	
		EFFLUENT PRESSURE	PIC-0300A	AI	HARDWIRE	X-XX	PSI	PE/PIT-0300A	PSCP	
		EFFLUENT PRESSURE	PIC-0300B	AI	HARDWIRE	X-XX	PSI	PE/PIT-0300B	PSCP	
		POST TOTAL CHLORINE	AIR-0300A	AI	HARDWIRE	0-5	PPM	AE/AIT-0300A	PSCP	
		POST PH	AIR-0300B	AI	HARDWIRE	0-14	STD	AE/AIT-0300B	PSCP	
		HIGH SERVICE PUMP NO.1 NOT IN REMOTE	HA-0301	DI	ETHERNET	ALARM	IN REMOTE	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 RUN COMMAND	YC-0301	DO	ETHERNET	START	STOP	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 MOTOR UNDERLOAD	JLA-0301	DI	ETHERNET	NORMAL	ALARM	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 MOTOR OVERLOAD	JHA-0301	DI	ETHERNET	NORMAL	ALARM	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 HIGH MOTOR TEMPERATURE	THA-0301	DI	ETHERNET	NORMAL	ALARM	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 DISC POSITION	ZA-0301A	DI	ETHERNET	NORMAL	ALARM	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 DISC POSITION	ZA-0301B	DI	ETHERNET	NORMAL	ALARM	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 RUNNING	YIR-0301	DI	ETHERNET	RUNNING	-	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 DRIVE FAULT	YA-0301	DI	ETHERNET	NORMAL	ALARM	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 SPEED COMMAND	SCR-0301	AO	ETHERNET	0-60	HZ	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.1 SPEED FEEDBACK	SIR-0301	AI	ETHERNET	0-60	HZ	03-HSP-01 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 NOT IN REMOTE	HA-0302	DI	ETHERNET	ALARM	IN REMOTE	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 RUN COMMAND	YC-0302	DO	ETHERNET	START	STOP	03-HSP-02 VFD	PSCP	

NO	SHEET #	DESCRIPTION	TAG	TYPE	SIGNAL	RANGE / OFF STATUS	UNITS / ON STATUS	FIELD WIRING DATA		NOTES
								FIELD ISA SIGNAL SOURCE / DESIGNATION	CONTROL PANEL	
		HIGH SERVICE PUMP NO.2 MOTOR UNDERLOAD	JLA-0302	DI	ETHERNET	NORMAL	ALARM	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 MOTOR OVERLOAD	JHA-0302	DI	ETHERNET	NORMAL	ALARM	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 HIGH MOTOR TEMPERATURE	THA-0302	DI	ETHERNET	NORMAL	ALARM	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 DISC POSITION	ZA-0302A	DI	ETHERNET	NORMAL	ALARM	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 DISC POSITION	ZA-0302B	DI	ETHERNET	NORMAL	ALARM	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 RUNNING	YIR-0302	DI	ETHERNET	RUNNING	-	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 DRIVE FAULT	YA-0302	DI	ETHERNET	NORMAL	ALARM	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 SPEED COMMAND	SCR-0302	AO	ETHERNET	0-60	HZ	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.2 SPEED FEEDBACK	SIR-0302	AI	ETHERNET	0-60	HZ	03-HSP-02 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 NOT IN REMOTE	HA-0303	DI	ETHERNET	ALARM	IN REMOTE	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 RUN COMMAND	YC-0303	DO	ETHERNET	START	STOP	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 MOTOR UNDERLOAD	JLA-0303	DI	ETHERNET	NORMAL	ALARM	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 MOTOR OVERLOAD	JHA-0303	DI	ETHERNET	NORMAL	ALARM	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 HIGH MOTOR TEMPERATURE	THA-0303	DI	ETHERNET	NORMAL	ALARM	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 DISC POSITION	ZA-0303A	DI	ETHERNET	NORMAL	ALARM	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 DISC POSITION	ZA-0303B	DI	ETHERNET	NORMAL	ALARM	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 RUNNING	YIR-0303	DI	ETHERNET	RUNNING	-	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 DRIVE FAULT	YA-0303	DI	ETHERNET	NORMAL	ALARM	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 SPEED COMMAND	SCR-0303	AO	ETHERNET	0-60	HZ	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 SPEED FEEDBACK	SIR-0303	AI	ETHERNET	0-60	HZ	03-HSP-03 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 NOT IN REMOTE	HA-0304	DI	ETHERNET	ALARM	IN REMOTE	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 RUN COMMAND	YC-0304	DO	ETHERNET	START	STOP	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 MOTOR UNDERLOAD	JLA-0304	DI	ETHERNET	NORMAL	ALARM	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.3 MOTOR OVERLOAD	JHA-0304	DI	ETHERNET	NORMAL	ALARM	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 HIGH MOTOR TEMPERATURE	THA-0304	DI	ETHERNET	NORMAL	ALARM	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 DISC POSITION	ZA-0304A	DI	ETHERNET	NORMAL	ALARM	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 DISC POSITION	ZA-0304A	DI	ETHERNET	NORMAL	ALARM	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 RUNNING	YIR-0304	DI	ETHERNET	RUNNING	-	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 DRIVE FAULT	YA-0304	DI	ETHERNET	NORMAL	ALARM	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 SPEED COMMAND	SCR-0304	AO	ETHERNET	0-60	HZ	03-HSP-04 VFD	PSCP	
		HIGH SERVICE PUMP NO.4 SPEED FEEDBACK	SIR-0304	AI	ETHERNET	0-60	HZ	03-HSP-04 VFD	PSCP	
	1-201	SODIUM HYDROXIDE STORAGE TANK LEVEL	LIR-0400	AI	HARDWIRE	0-XX	FEET	LE/LIT-0400	PSCP	
		SODIUM HYDROXIDE STORAGE TANK LEVEL LOW	LLA-0400	DI	HARDWIRE	NORMAL	ALARM	LE/LIT-0400	PSCP	
		SODIUM HYDROXIDEMETERING PUMP NO.1 NOT IN REMOTE	EA-0401	DI	HARDWIRE	ALARM	IN REMOTE	CONTROL PANEL	PSCP	
		SODIUM HYDROXIDE METERING PUMP NO.1 DRIVE FAULT	YA-0401	DI	HARDWIRE	NORMAL	ALARM	CONTROL PANEL	PSCP	
		SODIUM HYDROXIDE METERING PUMP NO.1 RUN COMMAND	YC-0401	DO	HARDWIRE	START	STOP	CONTROL PANEL	PSCP	
		SODIUM HYDROXIDE METERING PUMP NO.1 RUNNING	YIR-0401	DI	HARDWIRE	RUNNING	-	CONTROL PANEL	PSCP	
		SODIUM HYDROXIDE METERING PUMP NO.1 SPEED COMMAND	SCR-0401	AO	HARDWIRE	0-60	HZ	CONTROL PANEL	PSCP	
		SODIUM HYDROXIDE METERING PUMP NO.1 FEEDBACK	SIR-0401	AI	HARDWIRE	0-60	HZ	CONTROL PANEL	PSCP	
		SODIUM HYDROXIDE METERING PUMP NO.1 HIGH PRESSURE	PHA-0401	DI	HARDWIRE	NORMAL	ALARM	CONTROL PANEL	PSCP	
		SODIUM HYPOCHLORITE STORAGE TANK LEVEL	LIR-0500	AI	HARDWIRE	0-XX	FEET	LE/LIT-0500	PSCP	
		SODIUM HYPOCHLORITE STORAGE TANK LEVEL LOW	LLA-0500	DI	HARDWIRE	NORMAL	ALARM	LE/LIT-0500	PSCP	
		SODIUM HYPOCHLORITE METERING PUMP NO.2 NOT IN REMOTE	EA-0402	DI	HARDWIRE	ALARM	IN REMOTE	CONTROL PANEL	PSCP	
		SODIUM HYPOCHLORITE METERING PUMP NO.2 DRIVE FAULT	YA-0402	DI	HARDWIRE	NORMAL	ALARM	CONTROL PANEL	PSCP	
		SODIUM HYPOCHLORITE METERING PUMP NO.2 RUN COMMAND	YC-0402	DO	HARDWIRE	START	STOP	CONTROL PANEL	PSCP	
		SODIUM HYPOCHLORITE METERING PUMP NO.2 RUNNING	YIR-0402	DI	HARDWIRE	RUNNING	-	CONTROL PANEL	PSCP	

NO	SHEET #	DESCRIPTION	TAG	TYPE	SIGNAL	RANGE / OFF STATUS	UNITS / ON STATUS	FIELD WIRING DATA		NOTES
								FIELD ISA SIGNAL SOURCE / DESIGNATION	CONTROL PANEL	
		SODIUM HYPOCHLORITE METERING PUMP NO.2 SPEED COMMAND	SCR-0402	AO	HARDWIRE	0-60	HZ	CONTROL PANEL	PSCP	
		SODIUM HYPOCHLORITE METERING PUMP NO.2 FEEDBACK	SIR-0402	AI	HARDWIRE	0-60	HZ	CONTROL PANEL	PSCP	
		SODIUM HYPOCHLORITE METERING PUMP NO.2 HIGH PRESSURE	PHA-0402	DI	HARDWIRE	NORMAL	ALARM	CONTROL PANEL	PSCP	
		AMMONIA GAS SCALE WEIGHT	WIR-0601	AI	HARDWIRE	X-XX	LB	WE/WIT-0601	PSCP	
	I-202	AUTOMATIC TRANSFER SWITCH NOT IN AUTO	HA-0901	DI	HARDWIRE	ALARM	IN REMOTE	ATS CONTROL PANEL	PSCP	
		ATS UTILITY LOADING	EI-0901A	DI	HARDWIRE	-	-	ATS CONTROL PANEL	PSCP	
		ATS GENSET LOADING	EI-0901B	DI	HARDWIRE	-	-	ATS CONTROL PANEL	PSCP	
		ATS UTILITY AVALIBLE	EI-0901C	DI	HARDWIRE	-	-	ATS CONTROL PANEL	PSCP	
		ATS GENSET AVALIBLE	EI-0901D	DI	HARDWIRE	-	-	ATS CONTROL PANEL	PSCP	
		AUTOMATIC TRANSFER SWITCH FAULT	YA-0901	DI	HARDWIRE	NORMAL	ALARM	ATS CONTROL PANEL	PSCP	
		GENERATOR NOT IN AUTO	HA-0902	DI	HARDWIRE	ALARM	IN REMOTE	GENERATOR CONTROL PANEL	PSCP	
		GENERATOR FAULT	YA-0902	DI	HARDWIRE	NORMAL	ALARM	GENERATOR CONTROL PANEL	PSCP	
		GENERATOR RUNNING	YIR-0902	DI	HARDWIRE	RUNNING	-	GENERATOR CONTROL PANEL	PSCP	
		FUEL STORAGE TANK LEVEL	LIR-0902	AI	HARDWIRE	X-XX	FEET	GENERATOR CONTROL PANEL	PSCP	
		FUEL STORAGE TANK LEVEL LOW	LSLA-0902	DI	HARDWIRE	NORMAL	ALARM	GENERATOR CONTROL PANEL	PSCP	
		FUEL STORAGE TANK LEAK	LSA-0902	DI	HARDWIRE	NORMAL	ALARM	GENERATOR CONTROL PANEL	PSCP	
		ELECTRICAL ROOM HIGH TEMPERATURE	THA-0903	DI	HARDWIRE	NORMAL	ALARM	TSH-0903	PSCP	
		PUMP ROOM HIGH TEMPERATURE	THA-0904	DI	HARDWIRE	NORMAL	ALARM	TSH-0904	PSCP	
		EYEWASH STATION IN USE	YA-0905	DI	HARDWIRE	NORMAL	ALARM	FS-0905	PSCP	
		NETWORK RACK UPS FAULT	YA-0906	DI	HARDWIRE	NORMAL	ALARM	UPS	PSCP	
		DUCT SMOKE DETECTOR ACTIVE	YA-0907A	DI	HARDWIRE	NORMAL	ALARM	AHU-1	PSCP	
		DUCT SMOKE DETECTOR ACTIVE	YA-0907B	DI	HARDWIRE	NORMAL	ALARM	AHU-2	PSCP	
END										

FIELD INSTRUMENT SCHEDULE

Instrument Description	Tag	Type	Units	Range	Setpoint	Size	Manufacturer	Model Number	Transmitter #	Power Supply	Output	Sheet #	Notes
INFLUENT PRESSURE TRANSMITTER	PIT-0100	TRANSDUCER	PSI			1/2-INCH	ROSEMOUNT	3051		LOOP	4-20 mA DC	I-200	316SS WETTED PARTS, GAUGE PRESSURE
INFLUENT PRESSURE GAUGE	PI-0100	BOURDON TUBE	PSI	-	-	1/2-INCH	ASHCROFT	1009	-	-	4.5" FACE	I-200	316SS TUBE AND SOCKET, SILICONE FILLED
INFLUENT FLOW METER	FE/FIT-0100	MAGNETIC	GPM			8-INCH	E+H	PROMAG W400	REMOTE W/ DISPLAY	120 VAC	ETHERNET/IP	I-200	316L BULLET ELECTRODE, POLY LINER, 150# STEEL FLG, SS GROUND RINGS, AL COATED TRANSMITTER, 0.5% CAL
GST FLOAT SWITCHES	LSXX-0100	FLOAT	FT	-	SEE DRAWINGS	-			-	-	FORM A	I-200	NSF APPROVAL
GST LEVEL TRANSMITTER	LE/LIT-0100	ULTRASONIC	FT	-	-	1" NPT	SIEMENS	XPS	HYDRORANGER 200	120 VAC	4-20 mA DC	I-200	6 DEGREE, PVDF WETTED PARTS
RECIRCULATION PUMP PRESSURE GAUGE	PI-0201	BOURDON TUBE	PSI	-	-	1/2-INCH	ASHCROFT	1009	-	-	4.5" FACE	I-200	316SS TUBE AND SOCKET, SILICONE FILLED
RECIRCULATION PUMP FLOW METER	FE/FIT-0200	MAGNETIC	GPM	-	-	6-INCH	E+H	PROMAG W400	REMOTE W/ DISPLAY	120 VAC	ETHERNET/IP	I-200	316L BULLET ELECTRODE, POLY LINER, 150# STEEL FLG, SS GROUND RINGS, AL COATED TRANSMITTER, 0.5% CAL
HSP NO.1 DISCHARGE PRESSURE GAUGE	PI-0301	BOURDON TUBE	PSI	-	-	1/2-INCH	ASHCROFT	1009	-	-	4.5" FACE	I-200	316SS TUBE AND SOCKET, SILICONE FILLED
HSP NO.2 DISCHARGE PRESSURE GAUGE	PI-0302	BOURDON TUBE	PSI	-	-	1/2-INCH	ASHCROFT	1009	-	-	4.5" FACE	I-200	316SS TUBE AND SOCKET, SILICONE FILLED
HSP NO.3 DISCHARGE PRESSURE GAUGE	PI-0303	BOURDON TUBE	PSI	-	-	1/2-INCH	ASHCROFT	1009	-	-	4.5" FACE	I-200	316SS TUBE AND SOCKET, SILICONE FILLED
HSP NO.4 DISCHARGE PRESSURE GAUGE	PI-0304	BOURDON TUBE	PSI	-	-	1/2-INCH	ASHCROFT	1009	-	-	4.5" FACE	I-200	316SS TUBE AND SOCKET, SILICONE FILLED
EFFLUENT PRESSURE TRANSMITTER	PIT-0300A	TRANSDUCER	PSI			1/2-INCH	ROSEMOUNT	3051		LOOP	4-20 mA DC	I-200	316SS WETTED PARTS, GAUGE PRESSURE
EFFLUENT PRESSURE TRANSMITTER	PIT-0300B	TRANSDUCER	PSI			1/2-INCH	ROSEMOUNT	3051		LOOP	4-20 mA DC	I-200	316SS WETTED PARTS, GAUGE PRESSURE
EFFLUENT FLOW METER	FE/FIT-0300	MAGNETIC	GPM	-	-	12-INCH	E+H	PROMAG W400	REMOTE W/ DISPLAY	120 VAC	ETHERNET/IP	I-200	316L BULLET ELECTRODE, POLY LINER, 150# STEEL FLG, SS GROUND RINGS, AL COATED TRANSMITTER, 0.5% CAL
AMMONIA ANALYZER	AE/AIT-XXX												PROVIDED BY CLIENT, INSTALLED BY CONTRACTOR

General Notes

PROCESS FLUID: POTABLE WATER, TEMP - 30 -100 DEG F

1. ALL WETTED PARTS SHALL BE COMPATIBLE WITH THE PROCESS FLUID WITH NSF APPROVAL.

2. INSTALL ALL INSTRUMENT PER MANUFACTURES RECOMMENDATIONS AND INSTALLATION DETAILS PER CONTRACT DRAWINGS.

3. FACTORY CALIBRATE ALL INSTRUMENTS PRIOR TO SHIPPING TO PROJECT SITE. IN ADDITION TO FACTORY CALIBRATION ALL PROCESS PROBES REQUIRE CORRELATION/MATRIX CORRECTION TO ACTUAL FIELD CONDITIONS.

4. PROVIDE REMOTE TRANSMITTERS / DISPLAYS FOR ALL INSTRUMENTS LOCATED HIGHER THAN 5 FEET FROM FINISHED FLOOR OR GRADE.

5. INSTRUMENT SPECIFIC NOTES APPLICABLE TO ALL SIMILAR INSTRUMENTS.

Universal Engineering Sciences

Florida's Leading Engineering Source

Report of Geotechnical Exploration

Proposed Goodland Storage Tank
2559 San Marco Road
Marco Island, Collier County, Florida

February 15, 2022
UES Project No.: 0530.2200005.0000

For: Tetra Tech



February 15, 2022

Mr. Tyler Wainright, P.E.

Tetra Tech

10600 Chevrolet Way, Suite 300

Estero, Florida 33928

Phone: (239) 390-1467

Email: Tyler.Wainright@tetrattech.com

**Site: Proposed Goodland Storage Tank
2559 San Marco Road
Marco Island, Collier County, Florida
UES Project No. 0530.2200005.0000**

Dear Tyler:

Universal Engineering Sciences (UES) has completed the subsurface exploration and geotechnical engineering evaluation for the above-referenced project in accordance with the geotechnical and engineering service agreement for this project. The scope of services was completed in accordance with our Geotechnical Exploration Proposal (0530.0122.00001) planned in conjunction with and authorized by you.

EXECUTIVE SUMMARY

The purpose of our subsurface exploration was to classify the nature of the subsurface soils and general geomorphic conditions and evaluate their impact upon the proposed construction. This report contains the results of our subsurface exploration at the site and our engineering interpretations of these, with respect to the project characteristics described to us including providing recommendations for site preparation and the design of the foundation system.

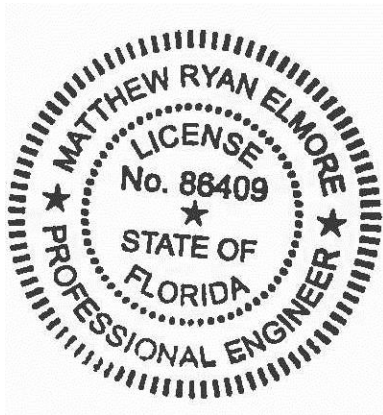
UES understands the project will consist of the new construction of a water storage tank located at the existing facility at 2559 San Marco Road, Marco Island, Collier County, Florida. We understand the proposed storage tank will be located at the same location of the existing storage tank and anticipated to be approximately 70-feet in diameter. We also understand the existing storage tank is currently supported on a wood driven pile foundation system, which is planned to be left in-place post demolition. No other project information was disclosed to UES at the time of this report. If the project description has been revised, please inform Universal Engineering Sciences so that we may review our recommendations with respect to any modifications.

Two Standard Penetration Test (SPT) borings advanced to a depth of approximately 90 feet below ground surface (BGS) were completed for this study.

The subsurface soil conditions encountered at this site generally consist of loose to very dense fine sands (SP), very loose slightly silty fine sands (SP-SM), medium dense slightly clayey fine sands (SP-SC), very loose to medium dense clayey fine sands (SC), loose to dense partially cemented slightly silty sands (SP-SM) with some amounts of gravel-size cemented sands, and hard limestone to the boring termination depths. Please refer to "Appendix D: Record of Test Borings" for a detailed account of each boring.

We appreciate the opportunity to be of service to you on this project and look forward to a continued association. Please do not hesitate to contact us if you have any questions or comments, or if we may further assist you as your plans proceed.

Respectfully Submitted,
Universal Engineering Sciences, LLC
Certificate of Authorization Number 549



Matthew R. Elmore, P.E. No. 86409
State of Florida
Engineering Services Manager

*This document has been digitally
signed and sealed by*

**Matthew
R Elmore**

Digitally signed by Matthew R
Elmore
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on the date adjacent to the seal.

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TABLE OF CONTENTS

1.0 INTRODUCTION.....	4
1.1 Scope of Services	4
1.2 Project Description	4
2.0 OBSERVATIONS.....	4
2.1 Site Inspection.....	4
2.2 Field Exploration	5
2.3 Laboratory Analysis.....	5
2.4 Geomorphic Conditions.....	5
2.5 Hydrogeological Conditions.....	6
3.0 ENGINEERING EVALUATION AND RECOMMENDATIONS.....	6
3.1 General	6
3.2 Site Preparation for Non-structural Grade Supported Elements	6
3.3 Driven Prestressed, Precast Concrete Pile Recommendations	7
4.0 CONSTRUCTION RELATED SERVICES	9
5.0 REPORT LIMITATIONS.....	9
6.0 BASIS FOR RECOMMENDATIONS	10
Appendix A - Vicinity Map	
Appendix B - Test Location Plan	
Appendix C - Notes Related to Borings	
Appendix D - Record of Test Borings	
Appendix E - Discussion of Soil Groups	



1.0 INTRODUCTION

1.1 Scope of Services

The objective of our geotechnical services was to collect subsurface data for the subject project, summarize the test results, and discuss any apparent site conditions that may have geotechnical significance for proposed structure construction. The scope of our services was limited to the following:

1. Conduct two Standard Penetration Test (SPT) borings to determine the nature and condition of the subsurface soils and preparing record logs of these soil borings depicting the subsurface soil conditions encountered during our field exploration.
2. Review each soil sample obtained during our field exploration for classification and additional testing, if necessary.
3. Evaluate the existing soil conditions found during our exploration with respect to foundation support for the proposed structure.
4. Prepare this report to document the results of our field exploration, engineering analysis and foundation design recommendations.

1.2 Project Description

UES understands the project will consist of the new construction of a water storage tank located at the existing facility at 2559 San Marco Road, Marco Island, Collier County, Florida. We understand the proposed storage tank will be located at the same location of the existing storage tank and anticipated to be approximately 70-feet in diameter. We also understand the existing storage tank is currently supported on a wood driven pile foundation system, which is planned to be left in-place post demolition. No other project information was disclosed to UES at the time of this report. If the project description has been revised, please inform Universal Engineering Sciences so that we may review our recommendations with respect to any modifications.

2.0 OBSERVATIONS

2.1 Site Inspection

The recovered samples were not evaluated, either visually or analytically, for chemical composition or environmental hazards. UES would be pleased to perform these services for an additional fee, if required.



2.2 Field Exploration

Our field exploration consisted of two Standard Penetration Test (SPT) borings advanced to a depth of approximately 90 feet below the existing ground surface (BGS) at the time of our field exploration. The locations of the borings performed are illustrated in "Appendix B: Test Location Plan". The Standard Penetration Test (SPT) boring method was used as the investigative tool within the borings. SPT tests were performed in substantial accordance with ASTM Procedure D-1586, "Penetration Test and Split-Barrel Sampling of Soils". This test procedure consists of driving a 1.4-inch I.D. split-tube sampler into the soil profile using a 140-pound hammer falling 30 inches. The number of blows per foot, for the second and third 6-inch increment, is an indication of soil strength.

The soil samples recovered from the soil borings were visually classified and their stratification is illustrated in "Appendix D: Record of Test Borings". It should be noted that soil conditions might vary between the strata interfaces shown on the logs. The soil boring data reflect information from a specific test location only. Site specific survey staking for the test locations was not provided for our field exploration. The indicated depth and location of each test was approximated based upon existing grade and estimated distances and relationships to obvious landmarks. The boring depths were selected based on our knowledge of vicinity soils and to include the zone of soil likely to be stressed by the proposed construction.

2.3 Visual Classification

Soil samples recovered from our field exploration were returned to our laboratory where they were visually classified in general accordance with ASTM D-2488. Samples were evaluated to obtain an accurate understanding of the soil properties and site geomorphic conditions. After performing a review of the recovered site soils, no laboratory testing was deemed necessary. Bag samples of the soil encountered during our field exploration will be held in our laboratory for your inspection for 30 days and then discarded unless we are notified otherwise in writing.

2.4 Geomorphic Conditions

Boring logs derived from our field exploration are presented in "Appendix D: Record of Test Borings". The boring logs depict the observed soils in graphic detail. The Standard Penetration Test borings indicate the penetration resistance, or N-values, logged during the drilling and sampling activities. The classifications and descriptions shown on the logs are generally based upon visual characterizations of the recovered soil samples. All soil samples reviewed have been depicted and classified in general accordance with the Unified Soil Classification System, modified as necessary to describe typical southwest Florida conditions. See "Appendix E: Discussion of Soil Groups", for a detailed description of various soil groups.

The subsurface soil conditions encountered at this site generally consist of loose to very dense fine sands (SP), very loose slightly silty fine sands (SP-SM), medium dense slightly clayey fine sands (SP-SC), very loose to medium dense clayey fine sands (SC), loose to dense partially cemented slightly silty sands (SP-SM) with some amounts of gravel-size cemented sands, and hard limestone to the boring termination depths. Please refer to "Appendix D: Record of Test Borings" for a detailed account of each boring.



2.5 Hydrogeological Conditions

On the date of our field exploration, the groundwater table was encountered at depths of approximately 6 to 7 feet below the existing ground surface. The groundwater table will fluctuate seasonally depending upon local rainfall and other site specific and/or local influences such as tidal events. Brief ponding of stormwater may occur across the site after heavy rains.

No additional investigation was included in our scope of work in relation to the wet seasonal high groundwater table or any existing well fields in the vicinity. Well fields may influence water table levels and cause significant fluctuations. If a more comprehensive water table analysis is necessary, please contact our office for additional guidance.

3.0 ENGINEERING EVALUATION AND RECOMMENDATIONS

3.1 General

A foundation system for any structure must be designed to resist bearing capacity failures, have settlements that are tolerable, and resist the environmental forces that the foundation may be subjected to over the life of the structure. The soil bearing capacity is the soil's ability to support loads without plunging into the soil profile. Bearing capacity failures are analogous to shear failures in structural design and are usually sudden and catastrophic.

The amount of settlement that a structure may tolerate is dependent on several factors including: uniformity of settlement, time rate of settlement, structural dimensions and properties of the materials. Generally, total or uniform settlement does not damage a structure but may affect drainage and utility connections. These can generally tolerate movements of several inches for building construction. In contrast, differential settlement affects a structure's frame and is limited by the structural flexibility.

UES understands the proposed structure is planned to be pile supported, such as the existing storage tank that is being replaced; coupled with the presence of shallow very loose to loose sands within the foundation influence zone, UES has provided recommendations for the support of the structure on a driven concrete pile foundation system. Recommendations for driven concrete piles are presented in section 3.3 of this report.

We note that the applicability of geotechnical recommendations is very dependent upon project characteristics, specifically (1) improvement locations, (2) grade alterations, (3) and actual applied structural loads. For that reason, UES must be provided with and review the preliminary and final site and grading plans, and structural design loads to validate all recommendations provided in this report. Without performing this review, our recommendations should not be relied upon for final design or construction of any site improvements.

3.2 Site Preparation for Non-structural Grade Supported Elements

UES recommends the following compaction requirements for this project:

- Proof Roll 95% of a Modified Proctor
- Slab on Grade Pad Fill 95% of a Modified Proctor
- Site Fill or Backfill 95% of a Modified Proctor



The compaction percentages presented above are based upon the maximum dry density as determined by a “modified proctor” test (ASTM D-1557). All density tests should be performed to a depth of 12 inches below the tested surface unless noted otherwise. All density tests should be performed using the nuclear method (ASTM D-6938) or the sand cone method (ASTM D-1556).

Our recommendations for preparation of the site for use of non-structural grade supported elements are presented below. This approach to improving and maintaining the site soils has been found to be successful on projects with similar soil conditions.

1. Initial site preparation should consist of performing stripping and clearing operations. This should be done within, and to a distance of five (5) feet beyond, the perimeter of the proposed building/pad footprint (including exterior isolated columns). During the clearing and grubbing operation, roots with a diameter greater than 1-inch or small roots in high density should be completely removed. These materials should be disposed of in areas designated by the Owner.
2. Following site stripping and prior the placement of any fill, areas of surficial sand (not exposed limestone) should be compacted (“proof rolled”) and tested. We recommend using a steel drum vibratory roller with sufficient static weight and vibratory impact energy to achieve the required compaction. Density tests should be performed on the proof rolled surface at a frequency of not less than one test per 2,500 square feet, or a minimum of four (4) tests, whichever is greater. Areas of exposed intact limestone shall be visually confirmed by the project geotechnical engineer prior to fill placement, in lieu of proof rolling.
3. Fill material may then be placed in the building pad as required. The fill material should be inorganic (classified as SP, SW, GP, GW, SP-SM, SW-SM, GW-GM, GP-GM) containing not more than 5 percent (by weight) organic materials. **Fill materials with silt-size soil fines in excess of 12% should not be used.** Fill should be placed in lifts with a maximum lift thickness not exceeding 12-inches. Each lift should be compacted and tested prior to the placement of the next lift. Density tests should be performed within the fill at a frequency of not less than one test per 2,500 square feet per lift in the building areas, or a minimum of four (4) tests per lift, whichever is greater. If fill is placed inside partially completed walls or other structural elements, care should be exercised to avoid damage to these elements.
4. The contractor should take into account the final contours and grades as established by the plan when executing his backfilling and compaction operations.

Using vibratory compaction equipment at this site may disturb adjacent structures. We recommend that you monitor nearby structures before and during proof-compaction operations. A representative of UES can monitor the vibration disturbance of adjacent structures. A proposal for vibration monitoring during compaction operations can be supplied upon request.

3.3 Driven Prestressed, Precast Concrete Pile Recommendations

Based upon the subsurface soil conditions encountered in the test borings, a summary of driven prestressed concrete pile capacities is presented in Table 1 below. The allowable loads were determined by using a factor of safety equal to at least 2 for compression, and a factor of safety of 3 for uplift.



TABLE 1 – SUMMARY OF DRIVEN PILE CAPACITIES (Concrete)			
Pile Size (Inches-square)	Estimated Pile Embedment Depth ⁽¹⁾ (Feet)	Allowable Compression Capacity (tons)	Allowable Tension Capacity (tons)
10	35 ⁽²⁾ (3)	33 – 40	10 – 14 ⁽⁴⁾
12	35 ⁽²⁾ (3)	43 – 52	12 - 16 ⁽⁴⁾
(1) Embedment depth is based upon the ground surface elevation at the time of this field exploration program. If any fill material is placed at the site, the pile embedment depth must be increased to achieve the desired pile tip elevation. (2) The above tonnages are based upon the piles achieving tonnage within the hard limestone layer that was encountered in the soil borings at depths ranging from 29 to 33 feet BGS, extending to depths of approximately 38 to 43 feet BGS. If the above estimated allowable pile capacities (compression and uplift) are not acceptable for design; UES can provide estimated capacities for embedment at deeper depths upon request. However, if deeper pile depths are needed it may be necessary to predrill through the before described hard limestone layer. (3) The actual final pile depths can be determined following completion of the test pile program. (4) The provided tonnages for tension support are based on full length or mechanically spliced piles.			

Lateral stability analysis has not been performed. UES anticipates that lateral stability will be provided by the foundation mat/structural slab at ground level.

We understand this project consists of the new storage tank to be located over the existing tank's footprint and the existing timber piles are to remain in-place. Because of this, we recommend that after the existing tank is demolished, the existing timber piles are surveyed, and an as-built plan is produced and provided to the structural engineer for design of the new pile foundation system. In addition, we recommend all existing timber piles are cut off, so the top of the piles are a minimum of 2-feet below the bottom of the pile cap/structural slab foundation. All sitework and fill placement operations should be completed prior to the installation of piles to avoid adverse impacts such as damage to the piles and/or negative skin friction resulting in increased pile settlement; this also includes all necessary work with the existing structure and existing foundations. It is recommended that a minimum center-to-center pile spacing of 3 times the nominal pile diameter (e.g., 36-inch minimum spacing for 12-inch piles) be maintained from the new and existing piles. We estimate settlement of a single pile to be ½-inch or less, most of it due to elastic shortening of the pile.

UES should be retained to monitor the installation of the driven pile foundation system for this project. UES's pile installation monitoring services will consist of monitoring the installation of each pile, documenting the number of hammer blows required to drive each pile for each linear foot, and evaluation of the pile driving records by a geotechnical engineer.

Once the pile size and pile driving equipment to be used for this project have been selected, a pile driving formula should be used to establish the pile driving criteria for the allowable pile load based on the pile driving hammer used. Each pile shall be driven until the established driving criteria have been achieved. If the required pile driving resistance isn't achieved at the end of the initial driving, pile freeze should be allowed to occur (by sitting for 24 hours) before re-driving to confirm pile capacity. If a pile does not achieve the design pile capacity after re-driving, the pile may have to be spliced and driven deeper and/or a help pile installed.



Pile load testing is not required for this project, in lieu of that, a minimum of five test piles should be driven at locations throughout the structure footprint to confirm the required production pile lengths. Test piles can be located at production pile locations and incorporated into the foundation system of the residential structure. Following the monitoring and evaluation of the test pile program by UES, production pile lengths and driving criteria can be finalized.

Piles should be driven with a hammer having a minimum energy proportionate to the size of the pile being driven. All pile driving operations should be performed in accordance with industry standards, applicable building codes, and the guidelines published by the Deep Foundations Institute (DFI).

Corrosivity testing has not been performed on the subsurface soils or ground water at the project site. Additionally, there is no mix specification available at this time for the concrete to be used for the piles for this project. Therefore, pile material durability cannot be evaluated at this time.

Using pile driving equipment at this site may disturb adjacent structures. We recommend that you monitor nearby structures before and during pile driving operations. A representative of UES International can monitor the vibration disturbance of adjacent structures. A proposal for vibration monitoring pile driving operations can be supplied upon request.

4.0 CONSTRUCTION RELATED SERVICES

We recommend the owner retain UES to provide inspection services during the site preparation procedures for confirmation of the adequacy of the earthwork operations. Field tests and observations include verification of foundation and/or pavement subgrades by monitoring earthwork operations and performing quality assurance tests of the placement of compacted structural fill courses.

The geotechnical engineering design does not end with the advertisement of the construction documents. The design is an on-going process throughout construction. Because of our familiarity with the site conditions and the intent of the engineering design, we are most qualified to address site problems or construction changes, which may arise during construction, in a timely and cost-effective manner.

5.0 REPORT LIMITATIONS

This consulting report has been prepared for the exclusive use of the current project owners and other members of the design team for the proposed Goodland water storage tank located at 2559 San Marco Road, Marco Island, Collier County, Florida. This report has been prepared in accordance with generally accepted local geotechnical engineering practices; no other warranty is expressed or implied. The evaluation submitted in this report, is based in part upon the data collected during a field exploration. However, the nature and extent of variations throughout the subsurface profile may not become evident until the time of construction. If variations then appear evident, it may be necessary to reevaluate information and professional opinions as provided in this report. In the event changes are made in the nature, design, or locations of the proposed structure, the evaluation and opinions contained in this report shall not be considered valid, unless the changes are reviewed and conclusions modified or verified in writing by Universal Engineering Sciences.



UES is not responsible for damage caused by soil improvement and/or construction activity vibrations related to this project. UES is also not responsible for damage concerning drainage or moisture related issues for the proposed or nearby structures.

UES should be provided the opportunity to review the final foundation design drawings and specifications to determine whether UES's recommendations have been properly interpreted, communicated and implemented. If UES is not afforded the opportunity to participate in construction related aspects of foundation installation as recommended in this report or any report addendum, UES will accept no responsibility for the interpretation of our recommendations made in this report or on a report addendum for foundation performance.

6.0 BASIS FOR RECOMMENDATIONS

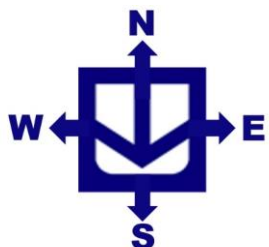
The analysis and recommendations submitted in this report are based on the data obtained from the tests performed at the locations indicated on the attached figure in Appendix B. This report does not reflect any variations, which may occur between borings. While the borings are representative of the subsurface conditions at their respective locations and for their vertical reaches, local variations characteristic of the subsurface soils of the region are anticipated and may be encountered. The delineation between soil types shown on the soil logs is approximate and the description represents our interpretation of the subsurface conditions at the designated boring locations on the particular date drilled.

Any third party reliance of our geotechnical report or parts thereof is strictly prohibited without the expressed written consent of Universal Engineering Sciences. The methodology (ASTM D-1586) used in performing our borings and for determining penetration resistance is specific to the sampling tools utilized and does not reflect the ease or difficulty to advance other tools or materials.



Appendix A - Vicinity Map





VICINITY MAP

SOURCE: GOOGLE EARTH PRO©

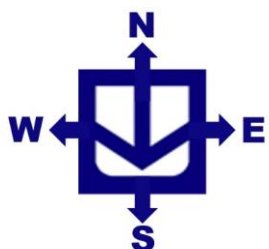
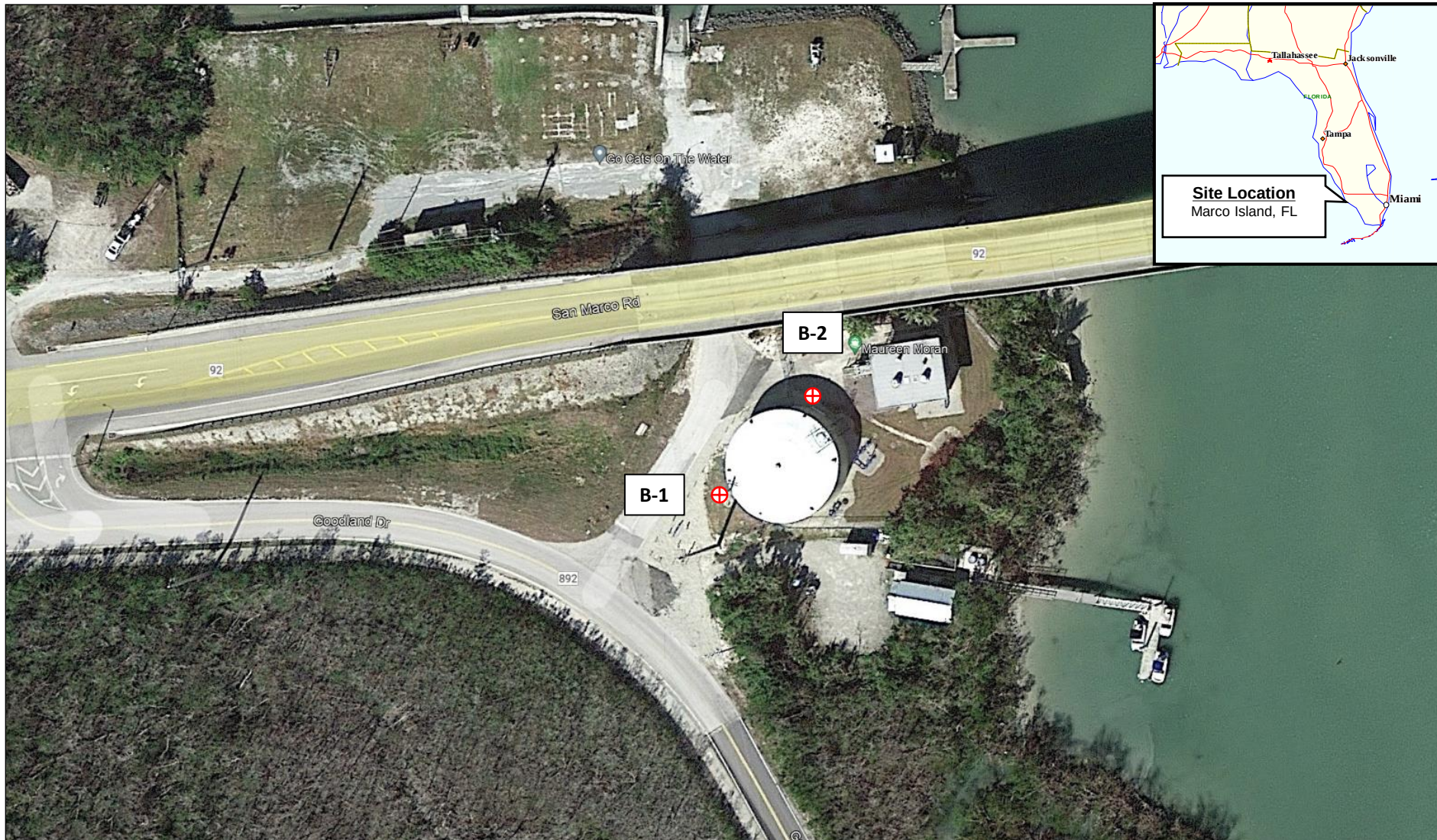
UNIVERSAL
ENGINEERING SCIENCES

Proposed Goodland Storage Tank
2559 San Marco Road
Marco Island, Collier County, FL

Drawn By: Ashok Neela	Checked By: MRE	Date: 02/14/22
Project No.: 0530.2200005.0000		Approved By: Adam Dornacker, P.E.

Appendix B - Test Location Plan





⊕ = SPT Boring Location

TEST LOCATION PLAN

SOURCE: GOOGLE EARTH PRO©

UNIVERSAL
ENGINEERING SCIENCES

Proposed Goodland Storage Tank
2559 San Marco Road
Marco Island, Collier County, FL

Drawn By: Ashok Neela	Checked By: MRE	Date: 2/14/22
Project No.: 0530.2200005.0000		Approved By: Adam Dornacker, P.E.

Appendix C - Notes Related to Borings



**NOTES RELATED TO
RECORDS OF TEST BORING AND
GENERALIZED SUBSURFACE PROFILE**

1. Groundwater level was encountered and recorded (if shown) following the completion of the soil test boring on the date indicated. Fluctuations in groundwater levels are common; consult report text for a discussion.
2. The boring location was identified and located in the field based on measured and estimated distances from existing site features.
3. The borehole was backfilled to site grade following boring completion, patched with asphalt cold patch mix when pavement was encountered.
4. The Record of Test Boring represents our interpretation of field conditions based on engineering examination of the soil samples.
5. The Record of Test Boring is subject to the limitations, conclusions, and recommendations presented in the report text.
6. The Standard Penetration Test (SPT) was performed in accordance ASTM Procedure D-1586. SPT testing procedure consists of driving a 1.4-inch I.D. split-tube sampler into the soil profile using a 140-pound hammer falling 30 inches.
7. On the Record of Test Boring listed as "Blow Counts", the N-value is the sum of the SPT hammer blows required to drive the split-tube sampler through the second and third 6-inch increment of the sampling layer, and is an indication of soil strength.
8. Shown on the Record of Test Boring an SPT N-value expressed as 50/2" is descriptive of the fact that 50 hammer blows were required to drive the split-spoon sampler a distance of approximately 2 inches.
9. The soil/rock strata interfaces shown on the Records of Test Boring are approximate and may vary from those in the field. The soil/rock conditions shown on the Records of Test Boring refer to conditions at the specific location tested; soil/rock conditions may vary between test locations.

10. Relative density and consistency for sands/gravels, silts/clays, and limestone are described as follows:

Cohesionless Soils	
SPT (N-Value)	Relative Density
0 – 3	Very Loose
4 – 8	Loose
9 – 24	Medium Dense
25 – 40	Dense
Over 40	Very Dense

Silts and Clays	
SPT (N-Value)	Consistency
0 – 1	Very Soft
2 – 4	Soft
4 – 6	Firm
7 – 12	Stiff
13 – 24	Very Stiff
Over 24	Hard

Limestone	
SPT (N-Value)	Relative Density
0 – 19	Very Soft
20 – 49	Soft
50 – 100	Medium Hard
50 for 3 to 5"	Moderately Hard
50 for 0 to 2"	Hard

11. Definition of descriptive terms of modifiers for silts/clays/shells/gravels are described as follows:

Percentage of Modifier Material	First Qualifier	Second Qualifier
0 – 5	With a Trace of + Modifier	With a Trace
5 – 12	Slightly + Modifier + y	With Little
12 – 30	Modifier + y	With Some
30 – 50	Very + Modifier + y	And

12. Descriptive characteristics for organic content percentages are described as follows:

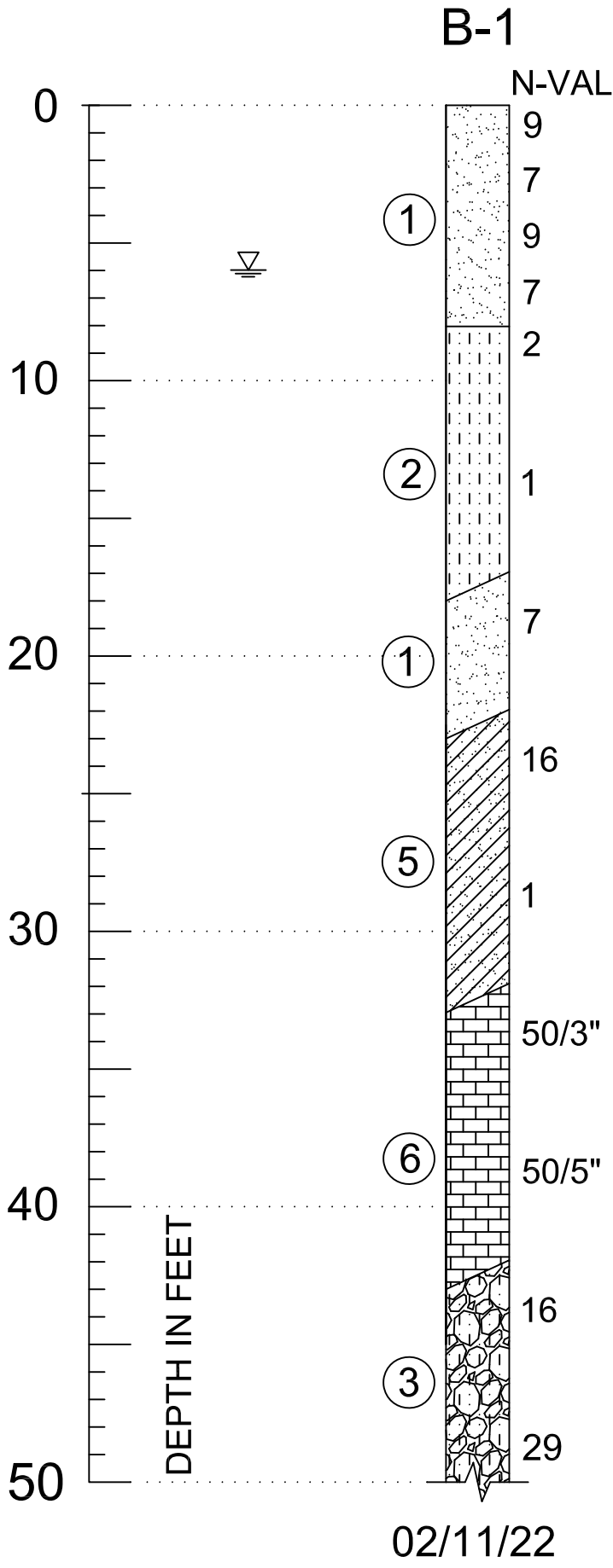
Percentage of Organic Material	Descriptor
0 – 5	With a Trace
5 – 20	With Organics
20 – 75	Highly Organic
75 – 100	Peat



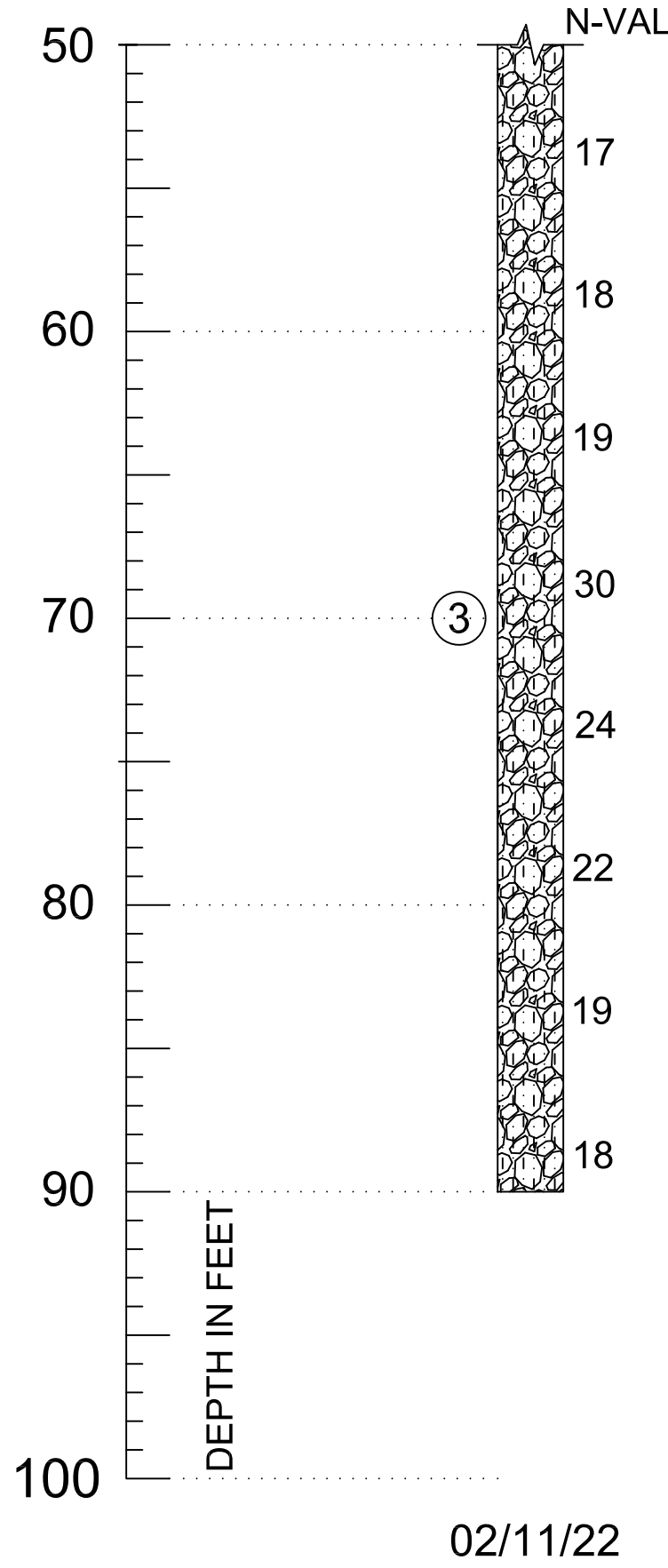
Appendix D - Record of Test Borings



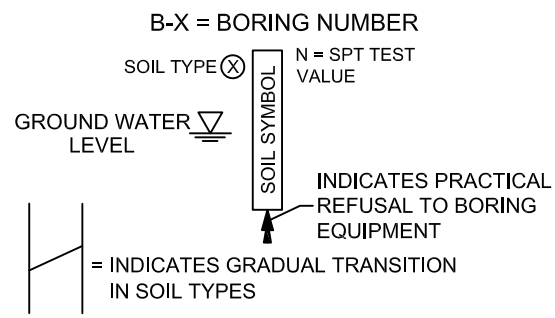
SOIL PROFILES



B-1 (Continued)



SOIL PROFILE LEGEND



NOTES:

N - STANDARD PENETRATION RESISTANCE TEST (SPT) VALUE. NUMBERS TO THE RIGHT OF BORINGS INDICATE SPT VALUE FOR 12-INCHES OF PENETRATION (UNLESS OTHERWISE NOTED).

WOH - BORING INTERVAL ADVANCED UNDER WEIGHT OF HAMMER.

WOR - BORING INTERVAL ADVANCED UNDER WEIGHT OF ROD.

LFC - LOSS OF DRILLING FLUID CIRCULATION.

WLS - WEATHERED LIMESTONE

HA - NO RECORDED N-VALUE DUE TO HAND AUGERING PROCEDURE

CS - CEMENTED SAND

SOIL LEGEND

- 1 Light Brown to Brown and Gray, SAND (SP) Loose to Very Dense
- 2 Light Brown to Brown and Gray, Slightly Silty SAND (SP-SM) Very Loose
- 3 Light Gray, Slightly Silty SAND (SP-SM), Partially Cemented With Some Amounts of Gravel-size Cemented Sands Loose to Dense
- 4 Light Gray, Slightly Clayey SAND (SP-SC) Medium Dense
- 5 Light Brown and Gray, Clayey SAND (SC) Very Loose to Medium Dense
- 6 Light Gray, LIMESTONE (LS) Hard

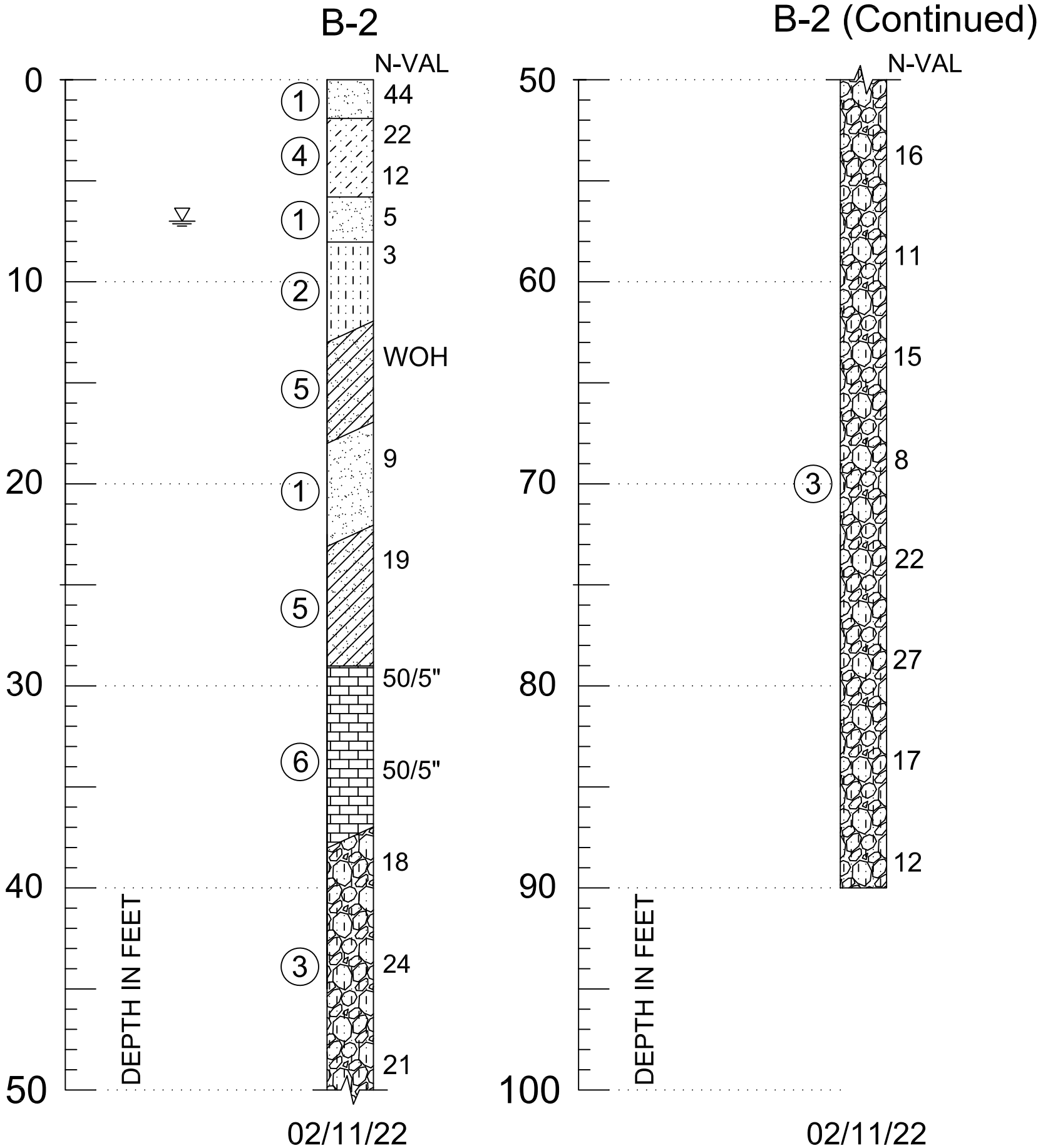
SOIL CLASSIFICATION

CORRELATION OF N - VALUES WITH RELATIVE DENSITY AND CONSISTENCY			CORRELATION OF N - VALUES WITH HARDNESS DESCRIPTION		
COHESIONLESS SOIL			LIMEROCK		
N - VALUE	RELATIVE DENSITY		N - VALUE	CONSISTENCY	RELATIVE DENSITY
0 - 3	VERY LOOSE		0 - 1	VERY SOFT	SOFT
4 - 8	LOOSE		2 - 4	SOFT	HARD
9 - 24	MEDIUM DENSE		5 - 6	FIRM	
25 - 40	DENSE		7 - 12	STIFF	
OVER 40	VERY DENSE		13 - 24	VERY STIFF	
			OVER 24	HARD	
APPROXIMATE FINES CONTENT MODIFIERS			APPROXIMATE SHELL CONTENT MODIFIERS		
5% TO 15%	SLIGHTLY SILTY OR SLIGHTLY CLAYEY		0% TO 5%	(NO MENTION)	
16% TO 25%	SILTY OR CLAYEY		6% TO 12%	SLIGHTLY SHELLY	
26% TO 49%	VERY SILTY OR VERY CLAYEY		13% TO 30%	SHELLY	
			31% TO 50%	VERY SHELLY	
DEFINITION OF DESCRIPTIVE TERMS OF MODIFIERS FOR SILTS/CLAYS/SHELLS/GRAVELS ARE DESCRIBED AS FOLLOWS:			APPROXIMATE ORGANIC CONTENT MODIFIERS		
PERCENTAGE OF MODIFIER MATERIAL	FIRST QUALIFIER	SECOND QUALIFIER	0% TO 2.5%	(NO MENTION)	
0 - 5	(NO MENTION)	(NO MENTION)	2.5% TO 5%	WITH A TRACE	
5 - 12	SLIGHTLY + MODIFIER + Y	WITH SOME	5% TO 20%	WITH ORGANICS	
12 - 30	MODIFIER + Y	AND	20% TO 75%	HIGHLY ORGANIC	
30 - 50	VERY + MODIFIER + Y		75% TO 100%	PEAT	



RECORD OF TEST BORINGS		
Universal Engineering Sciences 201 Waldo Ave. N. Lehigh Acres, Florida 33971 (239)-489-2443 www.universalengineering.com	Client: Tetra Tech Project No.: 0530.2200005.0000 Project: Goodland Storage Tank 2559 San Marco Road Marco Island, Collier County, Florida	Date: 2/15/2022 Drilled By: SUB Drawn By: AB Approved by: MRE

SOIL PROFILES



Appendix E - Discussion of Soil Groups



DISCUSSION OF SOIL GROUPS

COARSE GRAINED SOILS

GW and SW GROUPS. These groups comprise well-graded gravelly and sandy soils having little or no plastic fines (less than 5 percent passing the No. 200 sieve). The presence of the fines must not noticeably change the strength characteristics of the coarse-grained fraction and must not interface with its free-draining characteristics.

GP and SP GROUPS. Poorly graded gravels and sands containing little or no plastic fines (less than 5 percent passing the No. 200 sieve) are classed in GP and SP groups. The materials may be called uniform gravels, uniform sands or non-uniform mixtures of very coarse material and very fine sands, with intermediate sizes lacking (sometimes called skip-graded, gap-graded or step-graded). This last group often results from borrow pit excavation in which gravel and sand layers are mixed.

GM and SM GROUPS. In general, the GM and SM groups comprise gravels or sands with fines (more than 12 percent passing the No. 200 sieve) having low or no plasticity. The plasticity index and liquid limit of soils in the group should plot below the "A" line on the plasticity chart. The gradation of the material is not considered significant and both well and poorly graded materials are included.

GC and SC GROUPS. In general, the GC and SC groups comprise gravelly or sandy soils with fines (more than 12 percent passing the No. 200 sieve), which have a fairly high plasticity. The liquid limit and plasticity index should plot above the "A" line on the plasticity chart.

FINE GRAINED SOILS

ML and MH GROUPS. In these groups, the symbol M has been used to designate predominantly silty material. The symbols L and H represent low and high liquid limits, respectively, and an arbitrary dividing line between the two is set at a liquid limit of 50. The soils in the ML and MH groups are sandy silts, clayey silts or inorganic silts with relatively low plasticity. Also included are loess type soils and rock flours.

CL and CH GROUPS. In these groups the symbol C stands for clay, with L and H denoting low or high liquid limits, with the dividing line again set at a liquid limit of 50. The soils are primarily inorganic clays. Low plasticity clays are classified as CL and are usually lean clays, sandy clays or silty clays. The medium and high plasticity clays are classified as CH. These include the fat clays, gumbo clays and some volcanic clays.



OL and OH GROUPS. The soil in the OL and OH groups are characterized by the presence of organic odor or color, hence the symbol O. Organic silts and clays are classified in these groups. The materials have a plasticity range that corresponds with the ML and MH groups.

HIGHLY ORGANIC SOILS

The highly organic soils are usually very soft and compressible and have undesirable construction characteristics. Particles of leaves, grasses, branches, or other fibrous vegetable matter are common components of these soils. They are not subdivided and are classified into one group with the symbol PT. Peat humus and swamp soils with a highly organic texture are typical soils of the group.



APPENDIX B - COLLIER COUNTY SCADA STANDARDS

Collier County Public Utilities Division SCADA Standards

Section 2.6

Instrumentation

Revision 1.1



Contents

- 1.0 Field..... iii
 - 1.1 Instrumentation iii
 - 1.1.1 Introduction.....iii
 - 1.1.2 Common Features iii
 - 1.1.3 Flow Meters.....iv
 - 1.1.4 Pressure Transmitters viii
 - 1.1.5 Analytic Transmitters xi
 - 1.1.6 Level Transmitters.....xii

1.0 Field

1.1 Instrumentation

1.1.1 Introduction

1.1.1.1 Purpose

The purpose of this document is to establish Collier County enterprise-wide standards for the various instruments utilized throughout the Utility. Hardware and software standards are needed to provide uniformity across multiple projects. Specific goals include:

- Provide a common manufacturer and specific part for each of the various instruments.
- Define standards for the configuration of each of the instruments.
- Reduce installation, troubleshooting and maintenance of instruments by reducing the number of variations.

For further reference and additional information, please refer to the following documents.

- *4.0 Tagging Standards*
- *1.5 Allen Bradley PLC Standard*

1.1.1.2 Target Audience

It is expected that users of this document will have a general knowledge of PLC based control systems and a working knowledge of the various instrument in this document. In addition, users should have a working knowledge of Ethernet IP and Hart communications including their configuration and operation.

1.1.2 Common Features

All instruments will have the following:

- If installed outside of a building or any part of the wiring is run outside of a building there will be surge protection on the power conductors to the device.
- If installed outside of a building or any part of the wiring is run outside of a building there will be surge protection on the signal conductors to the device.
- All Instruments signal wire shielding will only be grounded in one location; typically the PLC panel.
- All signal wires will be a continuous run from the instrument to the PLC panel. No wire slices, wire nuts or other wire to wire connections are permitted. If the signal wires cannot be a single wire pull; they need to be terminated on a terminal strip within a control cabinet with appropriate documentation.

-
- All critical transmitters (2, 3, or 4 wires) will be powered by a battery backup or UPS power source.
 - Communication shall be in the following order of preference: Ethernet/IP, Hart or 4-20mA.
 - When networked devices are able to be configured via PLC profiles; the device should be setup to get its configuration from the PLC. Local configurations will be over-written.
 - Reference PLC standards for additional details.

1.1.3 Flow Meters

Flow meter sizing and material selection will be as specified by Engineers. The specific flow meters used will be Endress-Hauser Promag W400. There will be three separate configurations based on the communication media available to the flow meter.

1.1.3.1 General

- Installed in low point in pipe.
- Disable empty pipe detection.
- Enable low flow cutoff.
- Local totalizer in million gallons (MG).
- Bi-directional flow set based on application.
 - Totalizer logic will reside in the PLC
- Web server should be enabled and configured.
- Preferred communication to flow meter is Ethernet
 - 4-20ma if Ethernet is not available
 - Hart communication only if noted.

1.1.3.2 Installation Detail

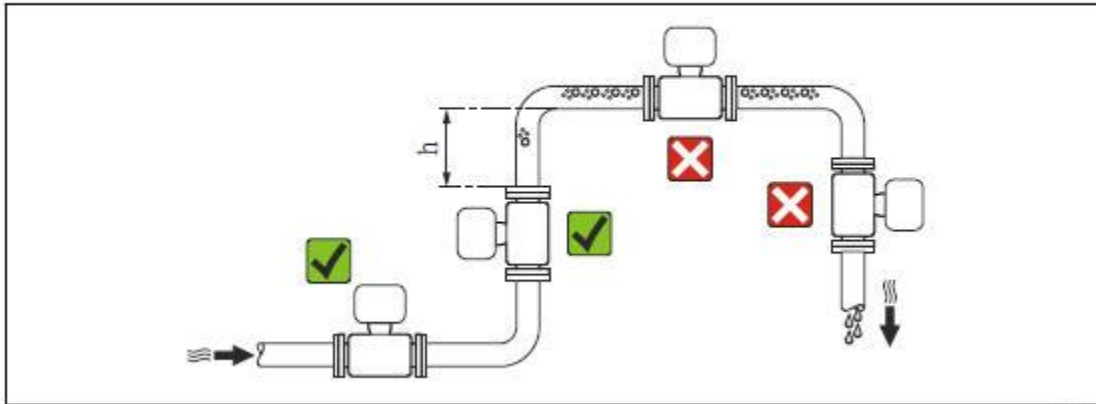
Installed per manufacturers recommendation.

Ordered with the ½" NPT (Option D) conduit connector.

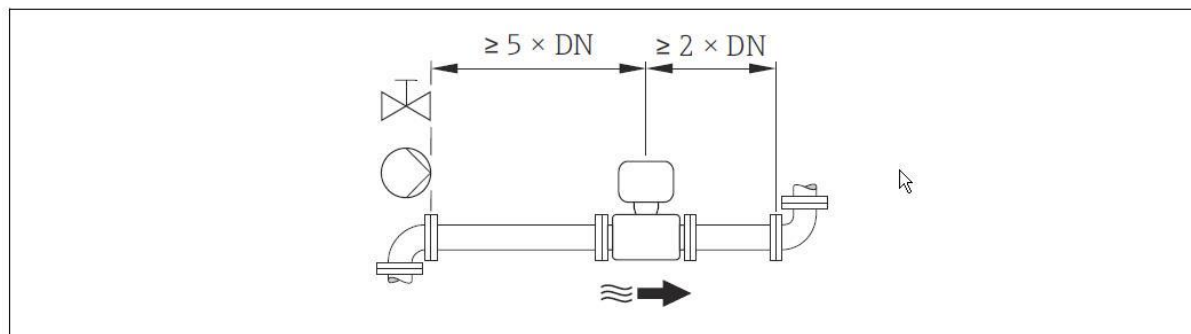
If remote transmitters/ displays are used; they should not be mounted further than 30 ft from the meter.

Provide sun shields or mount in PLC panel.

Mounting location



Inlet and outlet runs



1.1.3.3 Specification

Flow Meter

1. General:
 - a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
 - b. Type:
 - i. Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
 - ii. Full bore meter with magnetic field traversing entire flow-tube cross section.
 - iii. Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
 - c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
 - a. Stream Fluid:
 - i. As noted.
 - ii. Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.

-
- b. Flow Stream Descriptions: If and as described below.
 - 3. Operating Temperature:
 - a. Element:
 - i. Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - ii. Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - b. Transmitter:
 - i. Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - ii. Storage: 15 to 120 degrees F, typical, unless otherwise noted.
 - 4. Performance:
 - a. Flow Range: As noted.
 - b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
 - c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
 - 5. Features:
 - a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
 - b. No obstructions to flow.
 - c. Very low pressure loss.
 - d. Measures bi-directional flow.
 - 6. Process Connection:
 - a. Meter Size (diameter inches): As noted.
 - b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
 - i. Flange Material: Carbon steel, unless otherwise noted.
 - 7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
 - 8. Element:
 - a. Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.
 - b. Liner Material:
 - i. Teflon, unless otherwise noted.
 - ii. For potable water service, must have appropriate approvals.
 - c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
 - d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
 - e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
 - f. Grounding Ring:
 - i. Required, unless otherwise noted.
 - ii. Quantity: Two, unless otherwise noted.
 - iii. Material: Type 316 stainless steel, unless otherwise noted.

-
- g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
 - h. Submergence:
 - i. Temporary: If noted.
 - ii. Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
 - i. Direct Buried (3 to 10 feet): If noted.
 - j. Hazardous Area Certification:
 - i. Class 1, Division 2, Groups A, B, C, D: If noted.
 - ii. Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
 - iii. Class 1, Division 1, Groups C, D, and FM approved: If noted.
9. Transmitter:
- a. Mounting: Surface (wall), unless otherwise noted.
 - b. Display: Required, unless otherwise noted.
 - i. Digital LCD display, indicating flow rate and total.
 - ii. Bi-directional Flow Display: Required, unless otherwise noted.
 - iii. Forward and reverse flow rate.
 - iv. Forward, reverse and net totalization.
 - c. Parameter Adjustments: By keypad or non-intrusive means.
 - d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
 - e. Empty Pipe Detection:
 - i. If noted.
 - ii. Drives display and outputs to zero when empty pipe detected.
10. Signal Interface (at Transmitter):
- a. Network Interface: Ethernet 10/100 MB.
 - b. Analog Output:
 - i. Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
 - ii. Supports Superimposed Digital HART protocol: If noted.
 - c. Discrete Outputs: If noted.
 - i. Two discrete outputs, typical, rated for up to 30 volts, typical.
 - ii. Programmable as noted for the following typical parameters:
 - iii. Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.
 - d. Discrete Input: If noted.
 - i. Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
 - e. Other: As noted.
11. Cables:
- a. Types: As recommended by manufacturer.
 - b. Lengths: As required to accommodate device locations. No longer than 50'.
12. Built-in Diagnostic System:
- a. Features:
 - i. Field programmable electronics.
 - ii. Self-diagnostics with troubleshooting codes.

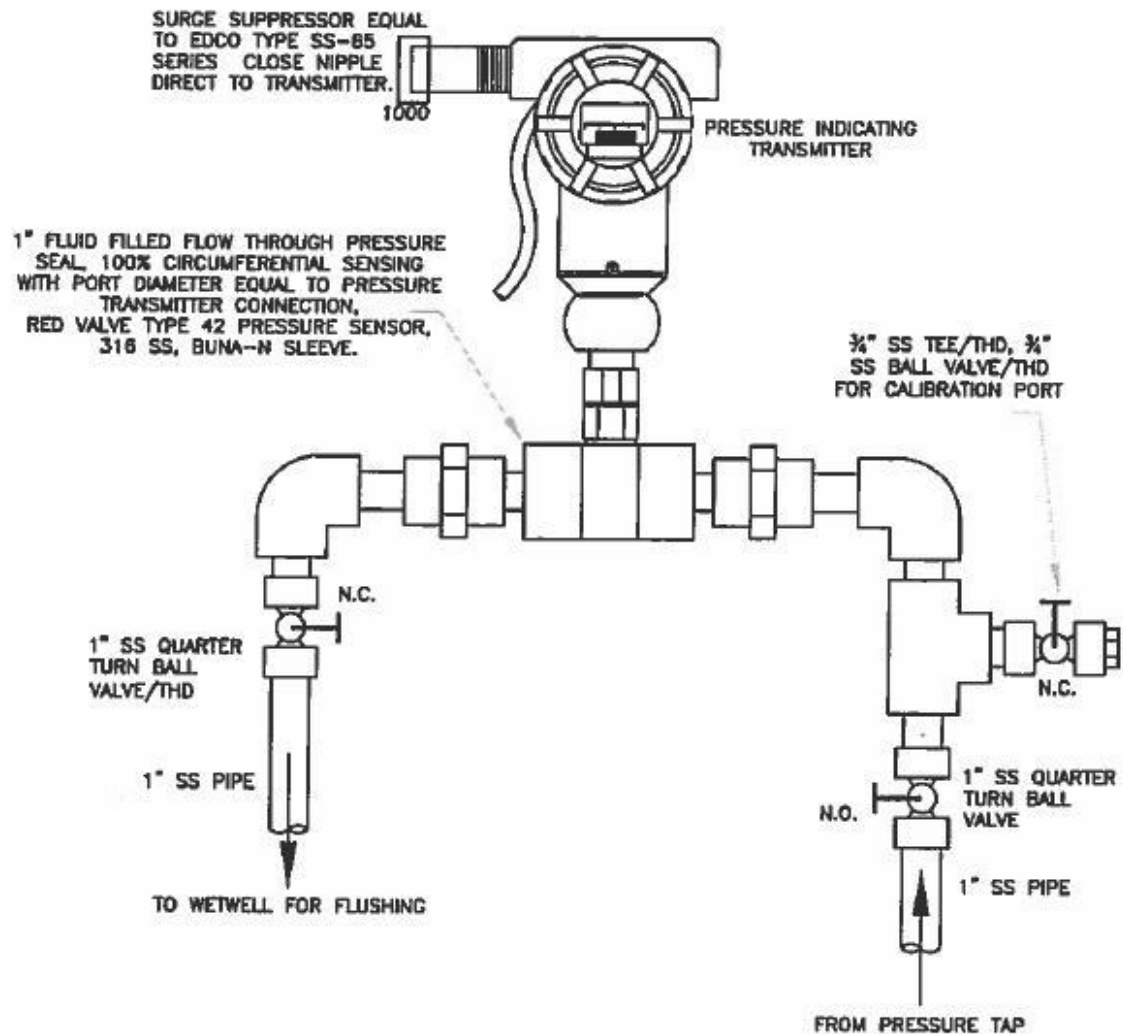
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- iii. Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
 - iv. Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
- a. Calibrated in an ISO 9001 and NIST certified factory.
 - b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
 - c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Factory Ready for Future In situ Verifications: If noted.
- a. Original meter parameter values available from vendor by request.
15. Accessories:
- a. In situ Verification System: If noted.
 - i. Quantity: One complete system provided for the Project.
 - ii. Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
 - iii. Physical access to the flow-tube not required.
 - iv. Meet standards established by the National Testing Laboratory.
 - v. Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
 - vi. Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
 - vii. Windows-based software
 - b. Primary Simulation System: If noted.
 - i. Quantity: One complete system provided for the Project.
 - ii. Verifies proper operation of the signal converter by simulating the flow meter's output signal.
 - iii. Generates pulsed dc excitation signal with a reference voltage of 70 mV.
 - iv. Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
 - v. Switch selectable for forward, reverse and zero flow rate.
 - vi. Verifies various input and output signals.
16. Manufacturer: Endress & Hauser; Proline Promag W400

1.1.4 Pressure Transmitters

Pressure transmitter sizing and material selection will be as specified by Engineers. The specific pressure transmitters used will be Emerson's Rosemount 3051 with Hart and integral manifold.

1.1.4.1 Installation Detail

The pressure assembly shall be installed per manufacturer's recommendation. At a minimum provide a process isolation valve, a purge/calibration port with an isolation valve and where required a diaphragm seal.



PRESSURE TRANSMITTER INSTALLATION
DETAIL (TYP.)

1.1.4.2 Specification

Pressure Transmitters

- a. General:
 - i. Function: Measure pressure and transmit signal proportional to pressure.
 - ii. Type:
 - 1. Electronic variable capacitance or silicon strain gauge.
 - 2. Two-wire transmitter; "smart electronics".
 - iii. Parts: Transmitter and accessories.
- b. Performance:
 - iv. Range: As noted.
 - 1. Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
 - v. Accuracy: Plus or minus 0.04 percent of span, unless otherwise noted.
 - vi. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
 - vii. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
 - viii. Humidity: 0 to 100 percent relative humidity.
 - ix. Hazardous Location Certifications: If and as noted.
- c. Features:
 - x. Type: Gauge pressure, unless otherwise noted.
 - xi. Adjustable damping.
 - xii. LCD indicator, unless otherwise noted.
 - 1. Display in either percent or engineering units, field configurable.
 - xiii. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
 - 1. Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
 - xiv. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
 - xv. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
 - xvi. Fill Fluid: Silicone, unless otherwise noted.
- d. Process Connections:
 - xvii. Line Size: As noted, minimum 1"
 - xviii. Connection Type: FNPT.
 - xix. Integrated Flow through Diaphragm Seal: If and as noted.

e. Signal Interface:

xx. Analog Output:

1. Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
 - a. Supports Superimposed Digital HART protocol: If noted.

f. Enclosure:

- xxi. Type: NEMA 4X.
- xxii. Materials: Coated aluminum, unless otherwise noted.
- xxiii. Mounting bracket, unless otherwise noted.
 1. Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.

g. Accessories:

- xxiv. Vent, Drain and Calibration valves as noted
 1. Type 316 stainless steel.

h. Manufacturers and Products:

- xxv. Gauge Pressure Units:
 1. Rosemount; Model 3051s TG.
- xxvi. Absolute Pressure Units:
 1. Rosemount; Model 3051s TA.

1.1.5 Analytic Transmitters

Analytic probe selection will be as specified by Engineers. The specific probes used will be from the Endress-Hauser Memosens line of probes with the Liquiline transmitters.

1.1.5.1 Configuration

1.1.5.2 Installation Detail

1.1.5.3 Specification

Analytical Multiparameter Element and Transmitter:

1. General:
 - a. Function: Measure, indicate, and transmit chemical analysis of process fluid.
 - b. Parts: Element, transmitter, interconnecting cable, and accessories as noted.
2. Element:
 - a. Manufacturer and Model: Emerson; Memosens analytical probes.
 - 1) Select specific model per analytical application.
 - 2) Provide sufficient length of interconnecting cable to link between analyzer probe and transmitter.

-
3. Transmitter:
 - a. Display:
 - 1) Graphic dot matrix LCD with LED backlighting.
 - 2) Auxiliary Readout:
 - a) Temperature.
 - b) Diagnostic warnings.
 - c) Error messages.
 - d) Other information.
 - b. Ambient Conditions:
 - 1) Temperature: 0 degrees F to plus 140 degrees F.
 - 2) Humidity: 10 to 95 percent, relative, noncondensing.
 - c. Signal Interface:
 - 1) Network Interface: Ethernet 10/100 MB via RJ45
 - 2) Analog Output:

Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.

Supports Superimposed Digital HART protocol:
If noted.

 - a) Outputs configured as needed to transmit readings from interfaced probes.
 - 3) Relay Outputs:
 - (1) One single-pin changeover contact alarm relay
 - 4) Serial Communication: If noted.
 - d. Enclosure: NEMA 4X/IP66 polycarbonate/aluminum.
 - e. Mounting Hardware: Suitable to support panel, surface, horizontal pipe, and vertical pipe mounting.
 - f. Power Requirements: 120V ac, 60-Hz.
 - g. Stainless steel equipment tag.
 4. Accessories:
 - a. Unless otherwise noted, provide submersion mounting hardware and mounting bracket as required to perform appropriate installation.
 - b. Provide sun shield for transmitter display.
 5. Manufacturer and Model: Emerson, Liquiline CM442 Transmitter with Memosens analytical probes.

1.1.6 Level Transmitters

Level transmitter sizing and material selection will be as specified by Engineers. There is no standard for the transmitter manufacture however the device must be either an ultrasonic or submersible type and must be Hart capable.

Collier County Public Utilities Division SCADA Standards

Section 1.3

Drives

Revision 1.1



Contents

- 1.0 Field..... 1
 - 1.3 Drives 1
 - 1.3.1 Introduction..... 1
 - 1.3.2 Common Features..... 1
 - 1.3.3 Specification 2

1.0 Field

1.3 Drives

1.3.1 Introduction

1.3.1.1 Purpose

The purpose of this document is to establish Collier County enterprise-wide standards for the various instruments utilized throughout the Utility. Hardware and software standards are needed to provide uniformity across multiple projects. Specific goals include:

- Provide a common manufacturer and specific part for each of the various instruments.
- Define standards for the configuration of each of the instruments.
- Reduce installation, troubleshooting and maintenance of instruments by reducing the number of variations.

For further reference and additional information, please refer to the following documents.

- *Spec 1.3 Drives*

1.3.1.2 Target Audience

It is expected that users of this document will have a general knowledge of PLC based control systems and a working knowledge of the drives in this document. In addition, users should have a working knowledge of Ethernet IP and Hart communications including their configuration and operation.

1.3.2 Common Features

All devices will have the following:

- Preferred signal wiring and communication is Ethernet,
- If installed outside of a building or any part of the wiring is run outside of a building there will be surge protection on all signal conductors to the device.
- All Instruments signal wire shielding will only be grounded in one location; typically the PLC panel.
- All signal wires will be a continuous run from the instrument to the PLC panel. No wire slices, wire nuts or other wire to wire connections are permitted. If the signal wires cannot be a single wire pull; they need to be terminated on a terminal strip within a control cabinet with appropriate documentation.
- The device configuration must be maintained through a loss of power.
- No local switches or LEDs unless otherwise noted, local controls and indications should use HIM.

- If there are local HOAs, need to be able to alert opps when either the local or HIM HOA is not in auto (If the drive is not available to be started remotely, opps should know).
- Include AC running contact to PLC
- Do not use ports 7 and 8 they are not available on all drives

1.3.3 Specification

SECTION 26 29 23

VARIABLE-FREQUENCY MOTOR CONTROLLER

PART 1 GENERAL

1.01 SUMMARY

- A. The Variable Frequency Drive (VFD) system shall contain all components required to meet the performance, protection, safety and certification criteria of this specification.

1.02 RELATED SECTIONS

- A. Section 26 05 00 – Common Work Results for Electrical
- B. Section 26 00 00 – Electrical – General Provisions

1.03 REFERENCES

- A. National Fire Protection Association - NFPA 70 - US National Electrical Code.
- B. National Electrical Manufacturers Association - NEMA 250 - Enclosures for Electrical Equipment.
- C. Underwriters Laboratory Inc. – UL 508.
- D. Canadian Standards Association International – CAN/CSA-C22.2 No. 14-05.
- E. International Electrical Code - IEC 146.
- F. Institute of Electrical and Electronics Engineers, Inc. - IEEE 519 - IEEE Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 30 00
- B. Shop Drawings - Approval
 1. Elevation Drawings: Include dimensional information and conduit routing locations.
 - a) All dimensions to be shown in inches
 2. Unit Descriptions: Include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
 3. Wiring Diagrams:
 - a) Power Diagram: Include amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, etc. as required for approval.

- b) Control Diagram: Include disconnect devices, pilot devices, etc.
 - 4. Major components list.
- C. Product Data Sheets
 - 1. VFD and Operator Interface publications.
 - 2. Data sheets and publications on all major components including but not limited to the following:
 - a) Contactors
 - b) Circuit breaker and fuse (power and control)
 - c) Control power transformers
 - d) Pilot devices
 - e) Relays/Timers
- D. Test procedures shall be per the manufacturer's standards.

1.05 CLOSEOUT SUBMITTALS (OPERATION AND MAINTENANCE MANUALS)

- A. Submit under provisions of Section 01 30 00
- B. Shop Drawings – Final as shipped
 - 1. Elevation Drawings: Include dimensional information and conduit routing locations.
 - 2. Unit Descriptions: Include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
 - 3. Wiring Diagrams:
 - a) Power Diagram: Include amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, etc. as required for approval.
 - b) Control Diagram: Include disconnect devices, pilot devices, etc.
 - 4. Major components list.
- C. Product Data Sheets
 - 1. VFD and Operator Interface publications.
 - 2. Data sheets and publications on all major components including but not limited to the following:
 - a) Contactors
 - b) Circuit breaker and fuse (power and control)
 - c) Control power transformers
 - d) Pilot devices
 - e) Relays/Timers
- D. Test procedures shall be per the manufacturer's standards.
- E. Operation and Maintenance Data
 - 1. Service and Contact information
 - 2. VFD and Operator Interface User Manuals
 - 3. Troubleshooting / Service Manuals
 - 4. Configuration Data

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers:

- a) The VFD and all associated optional equipment shall be UL listed or recognized.
- b) The VFD shall contain a UL label attached on the inside of the enclosure cabinet.

2. Suppliers:

- a) All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system and must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.
- b) The VFD shall be factory pre-wired, assembled and tested as a complete package.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
- B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of -25 °C to 55 °C (-13 °F to 130 °F).
- C. The contractor shall protect the units from dirt, water, construction debris and traffic.

1.08 WARRANTY

- A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.
- B. This warranty applies to variable frequency drive systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Allen-Bradley – PowerFlex 755 VFD (No substitutions) for HP > 400
- B. Allen-Bradley – PowerFlex 753 VFD (No substitutions) for HP > 30
- C. Allen-Bradley – PowerFlex 525 VFD (No substitutions) for HP ≤ 30

2.02 Model Selection

Model	HP Range	FLA Range	Harmonic Mitigation	Notes
PF525	≤30	<43	< 75 HP 6 pulse with passive filter	Upgraded to 753 at critical locations.
PF753	30 - 400	<415/477	≤ 75 HP 6 pulse with passive filter > 75 HP 18 Pulse	753 with 755 board allows 477 FLA
PF755	>400	>477	18 Pulse	

2.03 VARIABLE FREQUENCY DRIVE UNIT

A. Features

1. Certifications

- a) Listed to UL508C and CAN/CSA-C22.2 No. 14-05
- b) In conformity with EMC Directive (2004/108/EC) and Low Voltage Directive (2006/95/EC). Standards applied; EN 61800-3:2004, EN 61800-5-1:2007
- c) TÜV Rheinland - standards applied: EN 61800-3:2004, EN 61800-5-1:2007, EN ISO 13849-1:2008, EN ISO 13849-2:2003, EN 61800-5-2:2007, EN 61508 PARTS 1-7:2000, EN 62061:2005, and EN 60204-1:2006
- d) Australian Communications and Media Authority. In conformity with Radiocommunications Act: 1992, Radiocommunications Standard: 2008, and Radiocommunications Labeling Notice: 2008. Standards applied: EN 61800-3:2004
- e) Electric Power Research Institute. Certified compliant with standards SEMI F47 and IEC 61000-4-34
- f) Russian GOST-R Certificate No. POCC US.ME92.H00040
- g) American Bureau of Shipping (ABS) Certificate 11-HS743429-PDA
- h) Lloyd's Register Type Approval certificate 11/60008
- i) RINA Certificate ELE349811CS

2. Hardware

- a) Utilize diode bridge or SCR bridge on the input rectifier.
- b) Utilize DC bus inductor on all six-pulse VFDs only.
- c) Utilize switching logic power supply operating from the DC bus.
- d) Incorporate phase to phase and phase to ground MOV protection on the AC input line.
- e) Utilize gold plated plug-in connections on printed circuit boards.
- f) Microprocessor based inverter logic shall be isolated from power circuits.
- g) Utilize latest generation IGBT inverter section.
- h) Inverter section shall not require commutation capacitors.
- i) Embedded Ethernet port for direct network cable connections.
- j) Battery receptacle for Lithium battery power to the Real Time Clock.
- k) Additional DPI port for handheld and remote HIM options.
- l) Dedicated Digital Input for hardware enable.
- m) Conformal coated printed circuit boards.
- n) Optional onboard 24V DC Auxiliary Control Power Supply.

3. Control Logic

- a) Ability to operate with motor disconnected.
- b) Provide a controlled shut down, when properly protected, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
- c) Provide multiple programmable stop modes including Ramp, Coast, DC-Brake, Ramp-to-Hold, Fast Braking, and Current Limit Stop.
- d) Provide multiple acceleration and deceleration rates.
- e) Adjustable output frequency up to 650Hz.

4. DeviceLogix Control

- a) Ability to control outputs and manage status information locally within the VFD.
- b) Ability to function stand-alone or complimentary to supervisory control.
- c) Ability to speed reaction time by processing in the VFD.
- d) Ability to provide scaling, selector switches, or other data manipulations not already built into the VFD.
- e) Ability to read inputs/write outputs and exclusively control the VFD.
- f) Ability to provide an option for decision making if communication is lost with main controller.
- g) Ability to control other VFDs via a peer-to-peer EtherNet/IP network.
- h) Ability to write programs off-line.

5. Motor Control Modes

- a) Selectable Sensorless Vector, Flux Vector, V/Hz, Interior Permanent Magnet Motor, Surface Mount Permanent Magnet Motor, and Adjustable Voltage Control modes selectable through programming.
 - i. Frame 8 to 10 drives requires encoder to operate a surface permanent magnet motor.
- b) The drive shall be supplied with a Start-up and Auto-tune mode.
- c) The V/Hz mode shall be programmable for fan curve or full custom patterns.
- d) Capable of Open Loop V/Hz.

6. Current Limit

- a) Programmable current limit from 20 to 160% of rated output current.
- b) Current limit shall be active for all drive states: accelerating, constant speed and decelerating.
- c) The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.

7. Acceleration / Deceleration

- a) Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 to 3600 seconds.
- b) A second set of remotely selectable accel/decel settings shall be accessible through digital inputs.

8. Speed Profiles

- a) Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S Curve" profiles that provide changing accel/decel rates.
- b) S Curve profiles shall be adjustable.

9. Adjustments

- a) A digital interface can be used for all set-up, operation and adjustment settings.
- b) All adjustments shall be stored in nonvolatile memory.
- c) No potentiometer adjustments shall be required.
- d) Nonvolatile memory for factory default values shall be provided.
- e) Software must be available for trending and diagnostics, as well as online and offline programming functionality.

10. Process PID Control

- a) The drive shall incorporate an internal process PI regulator with proportional and integral gain adjustments as well as error inversion and output clamping functions.
- b) The feedback shall be configurable for normal or square root functions. If the feedback indicates that the process is moving away from the set-point, the regulator shall adjust the drive output until the feedback equals the reference.
- c) Process control shall be capable of being enabled or disabled with a hardware input. Transitioning in and out of process control shall be capable of being tuned for faster response by preloading the integrator.
- d) Protection shall be provided for a loss of feedback or reference signal.

11. Skip Frequencies

- a) Three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance shall be provided.
- b) The set points shall have a bandwidth adjustable from Maximum Reverse Speed to Maximum Forward Speed.

12. Fault Reset / Run

- a) The drive shall provide up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
- b) The automatic mode shall not be applicable to a ground fault, shorted output faults and other internal microprocessor faults.
- c) The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.

13. Run on Power Up

- a) A user programmable restart function shall be provided to allow restart of the equipment after restoration of power after long duration power outages. Restart time dependent on presence of incoming signal.

14. Fault Memory

- a) The last 32 fault codes shall be stored and time stamped in a fault buffer.
- b) Information about the drive's condition at the time of the last fault such as operating frequency, output current, dc bus voltage and twenty-seven other status conditions shall be stored.
- c) A power-up marker shall be provided at each power-up time to aid in analyzing fault data.
- d) The last 32 alarm codes shall be stored and time stamped for additional troubleshooting reference.

15. Overload Protection

- a) The drive shall provide internal class 10 adjustable overload protection.
- b) Overload protection shall be speed sensitive and adjustable.
- c) A viewable parameter shall store the overload usage.

16. Auto Economizer

- a) An auto economizer feature shall be available to automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage.
- b) When the load increases, the drive shall automatically return to normal operation.

17. Terminal Blocks

- a) For frames 1 to 7 a separate terminal blocks shall be provided for power wiring.
- b) For frames 8-10 power wiring is landed on robust L-brackets behind the drive unit. This wiring remains in-place if the drive unit is removed.
- c) Terminal blocks shall be provided for control wiring on all frames
- d) I/O terminal blocks shall be removable with wiring in place.

18. Flying Start

- a) The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. This feature is disabled by default.

19. Inputs and Outputs

- a) The Input / Output option modules shall consist of both analog and digital I/O.
- b) No jumpers or switches shall be required to configure digital inputs and outputs.
- c) All digital input and output functions shall be fully programmable.
- d) The control terminal blocks shall be rated for 115V AC.
- e) Inputs shall be optically isolated from the drive control logic.
- f) The control interface card shall provide input terminals for access to fixed drive functions that include start, stop, external fault, speed, and enable.
- g) The VFD shall be capable of supporting up to 10 analog inputs, 10 analog outputs, 31 digital inputs, 10 relay outputs, 10 transistor outputs, and 5 positive temperature coefficient (PTC) inputs.
- h) The Input / Output option modules shall have the following features:
 - i. Analog Inputs:
 - a. Shall not be required
 - ii. Analog Outputs:
 - a. Shall not be required
 - iii. Digital Inputs:
 - a. Quantity three (3) or six (6) digital inputs rated 24V DC/115V AC.
 - b. All inputs shall be individually programmable for multiple functions including: Start, Run, Stop, Auxiliary Fault, Speed Select, Jog and Process PI functions.
 - c. A single safety input (ATEX) shall be a configurable option for a thermostat or PTC temperature sensor.
 - iv. Digital Outputs:
 - a. At a minimum one (1) relay output (N.O. or N.C.).
 - b. For 240V AC or 24V DC, N.O. contact output ratings shall be 2 amp max., general purpose (inductive)/resistive. N.C. contact output ratings shall be 2 amp max., resistive only.
 - c. Relays shall be programmable to multiple conditions including: Fault, Alarm, At Speed, Drive Ready and PI Excess Error.
 - d. Timers shall be available for each output to control the amount of time, after the occurring event, that the output relay actually changes state.
 - e. Transistor outputs are available in quantities varying from zero (0) to two (2).
 - f. For 24V DC, transistor output rating shall be 1 amp max, Resistive.

20. Reference Signals

- a) The drive shall be capable of using the following input reference signals:
 - i. Preset speeds
 - ii. Digital MOP
 - iii. Human Interface Module
 - iv. Communication networks

21. Loss of Reference

- a) The drive shall be capable of sensing reference loss conditions.
- b) In the event of loss of the reference signal, the drive shall be user programmable to the following:
 - i. Alarm and maintain last reference.
- c) When using a communications network to control the drive, the communications adapter shall have these configurable responses to network disruptions and controller idle (fault or program) conditions:
 - i. Hold Last State

22. Metering

- a) At a minimum, the following parameters shall be accessible through the Human Interface Module, if installed:
 - i. Output Current in Amps
 - ii. Output Voltage in Volts
 - iii. Output Power in kW
 - iv. Elapsed MWh
 - v. DC Bus Voltage
 - vi. Frequency
 - vii. Heatsink Temperature
 - viii. Last eight (32) faults
 - ix. Elapsed Run Time
 - x. IGBT Temperature

23. Faults

- a) At a minimum, the following faults shall be accessible through the Human Interface Module:
 - i. Power Loss
 - ii. Undervoltage
 - iii. Overvoltage
 - iv. Motor Overload
 - v. Heat Sink Over-temperature
 - vi. Maximum Retries
 - vii. Phase to Phase and Phase to Ground Faults

24. Predictive Diagnostics

- a) At a minimum, the following predictive diagnostic features shall be provided:
 - i. Relay Output Life Cycles based on load type and amps.
 - ii. Hours of Fan Life based on load and ambient temperature.
 - iii. Motor Bearing life based on expected hours of use.
 - iv. Motor Lubrication schedule based on hours of use.
 - v. Machine Bearing life based on expected hours of use.

25. Real-Time Clock

- a) Shall be capable of providing time stamped events.
- b) Shall have the ability to be set locally or via a remote controller.
- c) Shall provide the ability to be programmable for month, day, year and local time zones in HH:MM:SS.

2.04 VFD PACKAGED SYSTEM

A. Features

1. Ratings

- a) Voltage
 - i. Capable of accepting nominal plant power of 400, 480, 600 or 690V AC at 50Hz or 60Hz.
 - ii. The supply input voltage tolerance shall be $\pm 10\%$ of nominal line voltage.
- b) Displacement Power Factor
 - i. Six-pulse VFD shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of 0.95 or better at rated load and nominal line voltage, over the entire speed range.
 - ii. Eighteen-pulse VFD shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of 0.98 or better at rated load and nominal line voltage, over the entire speed range.

c) Efficiency

- i. A minimum of 96.5% (+/- 1%) at 100% speed and 100% motor load at nominal line voltage.
- ii. Control power supplies, control circuits, and cooling fans shall be included in all loss calculations.

d) Operating ambient temperature range without derating: 0 °C to 40 °C (32 °F to 104 °F)

e) Operating relative humidity range shall be 5% to 95% non-condensing.

f) Operating elevation shall be up to 1000 Meters (3,300 ft) without derating.

2. Sizing

- a) Systems rated at Normal Duty loads shall provide 110% overload capability for up to one minute and 150% for up to 3 seconds.
- b) Systems rated at Heavy Duty loads shall provide 150% overload capability for up to one minute and 180% for up to 3 seconds.
- c) Systems rated at Light Duty loads (Frames 8 to 10) shall provide 110% overload capability for up to one minute with no 3 second overload

3. Auto Reset/Run

- a) For faults other than those caused by a loss of power or any other non-critical fault, the drive system shall provide a means to automatically clear the fault and resume operation.

4. Ride-Through

- a) The VFD system shall attempt to ride through power dips up to 20% of nominal. The duration of ride-through shall be inversely proportional to load. For outages greater than 20%, the drive shall stop the motor and issue a power loss alarm signal to a process controller, which may be forwarded to an external alarm signaling device.

5. Run on Power Up

- a) The VFD system shall provide circuitry to allow for remote restart of equipment after a power outage. Unless indicated in the contact drawings, faults due to power outages shall be remotely resettable. The VFD system shall indicate a loss of power to a process controller, which may be forwarded to an external alarm signaling device. Upon indication of power restoration the process controller will attempt to clear any faults and issue a run command, if desired.
- b) PLC shall be coded to toggle the run command once power is restored.

6. Communications

- a) VFD shall provide an embedded EtherNet/IP port.
- b) VFD shall be capable of communicating on multiple networks.
- c) VFD shall be capable of supporting the following network options:
 - i. EtherNet/IP
 - ii. Modbus/TCP
 - iii. Modbus RTU

7. Enclosure Door Mounted Human Interface Module (HIM)

- a) VFD shall provide a HIM with integral LCD display, operating keys and programming keys.
- b) An enclosure door-mounted HIM shall be provided
 - i. NEMA/UL Type 1 shall be provided for indoor dry locations.
 - ii. Outside or wet locations the HIM to be installed inside enclosure on deadfront.
- c) An optional VFD-mounted HIM, rated NEMA/UL Type 1, may be provided and shall be capable of connecting via a separate cable for use as a handheld terminal.
- d) The HIM shall have the following features:
 - i. A seven (7) line by twenty-one (21) character backlit LCD display with graphics capability.
 - ii. Shall indicate drive operating conditions, adjustments and fault indications.
 - iii. Shall be configured to display in the following three distinct zones:
 - a. The top zone shall display the status of direction, drive condition, fault / alarm conditions and Auto / Manual mode.
 - b. The middle zone shall display drive output frequency.
 - c. The bottom zone shall be configurable as a display for either programming menus / information or as a two-line user display for two additional values utilizing scaled units.
 - iv. Shall provide digital speed control.
 - v. The keypad shall include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), and numeric keys for direct entry.

B. Enclosure

1. Shall be rated NEMA/UL Type (1) or (12)
2. Shall be painted per the manufacturer's standard.
3. Shall provide entry and exit locations for power cables.
4. Shall contain a label for UL508.
5. The drive system nameplate shall be marked with system Short Circuit Current Rating (SCCR).

C. Drive Enclosure Input Disconnect

1. Provide an enclosure door interlocked disconnect with thermal magnet circuit breaker
2. Operator Handles
 - a) Provide externally operated main disconnect handle.
 - b) Handles shall be lockable with up to three lockout / tagout padlock positions.

D. Branch Circuit Protection

1. Inverse time circuit breaker shall be provided

E. Bypass **[Delete bypass option choices not used.]**

1. Manual Bypass Option:

- a) Shall provide a means to manually switch a single motor from drive control to bypass (across the line operation).
- b) Shall provide separate drive output and bypass contactors. The contactors shall be electrically and mechanically interlocked.
- c) Shall provide a Drive/Off/Bypass selector switch, mounted on the enclosure door, for selection of Drive and Bypass modes of operation.
- d) Provide a Class 10 overload for motor protection while operating in the bypass mode.

2. Automatic Bypass Option:

- a) Shall provide a means to automatically (upon a drive fault) switch a single motor from drive control to bypass (across the line operation).
- b) Shall provide separate drive output and bypass contactors. The contactors shall be electrically and mechanically interlocked.
- c) Shall provide a Drive/Off/Bypass selector switch, mounted on the enclosure door, for selection of Drive and Bypass modes of operation.
- d) Shall provide a Auto Bypass/Off/On selector switch, mounted on the enclosure door, for selection of Auto Bypass mode of operation.
- e) Provide a Class 10 overload for motor protection while operating in the bypass mode.

3. SMC Flex / Pump Option Bypass:

- a) Shall provide a means to switch a single motor from drive control to bypass via a soft start (across the line operation).
- b) Shall provide separate drive output and bypass contactors. The contactors shall be electrically and mechanically interlocked.
- c) Shall provide a Drive/Off/Bypass selector switch, mounted on the enclosure door, for selection of Drive and Bypass modes of operation.
- d) Provide a Class 20/30 overload for motor protection while operating in the bypass mode.
- e) Shall provide smooth deceleration when stopping in bypass mode.
- f) Shall provide a door-mounted HIM.
- g) Shall provide bypass fusing on input of RVSS bypass unit.

F. Control Power Transformer

- 1. Provide a control power transformer mounted and wired inside of the drive system enclosure.
- 2. The transformer shall be rated for the VFD power requirements.

G. Harmonic Mitigation Techniques

1. Less than 75 HP - Drive Input Line Reactor

- a) Provide a drive input line reactor mounted within the drive system enclosure for drives that are less than 100 horsepower.
- b) The line reactor shall meet the following specifications:
 - i. The construction shall be iron core with an impedance of (3 or 5) percent
 - ii. The winding shall be copper or aluminum wound.
 - iii. The insulation shall be Class H with a 115 °C rise over 50 °C ambient.
 - iv. The unit shall be rated for system voltage, ampacity, and frequency.

2. 75 HP or higher - 18-pulse VFD with Auto Transformer

- a) Provide VFD with a single 18-pulse converter.
 - i. The converter bridge shall be a parallel 18-pulse diode bridge assembly with DC snubber (board or assembly). Diodes shall be rated (devices) with a blocking voltage minimum of 1600V.
 - ii. The converter shall incorporate 1000V three phase block style MOV protection rated 85 °C.

- b) The drive system shall incorporate an 18-pulse phase shifting auto transformer with line reactor as an assembly. The 18-pulse assembly shall be wired into the VFD System enclosure where possible. The auto transformer shall have the following minimum features:
 - i. Rated for input rectifier duty and matched to VFD overload capability.
 - ii. Copper or aluminum wound.
 - iii. Class 180 or 220 insulation.
 - iv. Power factor of 0.98 or better at rated load and nominal line voltage.
 - v. Open core construction.
 - vi. One normally closed thermoswitch contact in each coil wired into a VFD control circuit.
- c) The drive system shall be compliant with IEEE519-1992 standards at the input VFD terminals based upon the input power phase imbalance within 0.5% of nominal line voltage and under full VFD output current ratings.

H. Auxiliary Relays

- 1. Provide relays for Drive Alarm, Drive Fault, Drive Run, and System Status Faults (as required).
- 2. The relays shall be Allen-Bradley 700-HC (2 N.O. & 2 N.C.). The relay contacts shall be rated for 115V AC/30V DC, 5.0 amp resistive, 2.5 amp inductive.

I. Control Interface

- 1. The control terminals shall be rated for 115V AC.
- 2. The control interface shall provide input terminals for access to VFD functions that include start, stop, external fault, speed select, and enable, as required.

J. Motor Heater Control – if specified

- 1. The drive system shall provide the drive control circuitry to energize an existing motor heater whenever the motor is not running via remote power.
- 2. The heater control shall be interlocked with the drive and/or bypass and shall be energized whenever the motor is not running. The source shall be remotely provided.

K. Hand/Off/Auto Selector Switch

1. Provide a "Hand/Off/Auto" selector switch, mounted on the enclosure door.
2. The "Hand/Off/Auto" selector switch shall start the drive in the "Hand" mode and stop the drive in the "Off" mode.
3. In the "Auto" mode the drive shall be started and stopped from a remote "RUN" contact.
4. In all modes, Auxiliary and Enable inputs to the drive control interface board must be present before the drive will start.
5. When a HIM is present, the stop function shall always be available to stop the drive regardless of the selected mode ("Hand" or "Auto"). The HIM will be non-functional (except for the display and programming) when the switch is in "Off" mode. The HIM shall stop the drive if the switch is in the "Auto" mode with the remote start contact initiated.
6. The drive speed reference shall be controlled from the HIM when in "Hand" mode (factory default setting).
7. The drive shall have the capability of smoothly transferring from the automatic speed reference to the manual speed reference on the HIM, without perturbation in the speed reference.
8. The drive speed reference shall be controlled by a speed input when in "Auto" mode.
9. The device shall be an Allen-Bradley Bulletin 800T (30mm) NEMA Type 4/13, mounted on the drive system enclosure door.

L. Motor Run Time Meter

1. Provide a digital, non-resettable, door-mounted elapsed time meter.
2. The meter shall be electrically interlocked with the Drive Run relay and Bypass contactor to indicate actual motor operating hours.

M. Output Filtering

1. DV/DT output filter (may affect the system SCCR rating)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that location is ready to receive equipment.
- B. Verify that the building environment can be maintained within the service conditions required by the manufacturer of the VFD.

3.02 INSTALLATION

- A. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.

3.03 START-UP SERVICE

- A. At a minimum, the start-up service shall include:
 1. Perform pre-Power Check
 2. Megger Motor Resistances: Phase-to-Phase and Phase-to-Ground
 3. Verify system grounding per manufacturer's specifications
 4. Verify power and signal grounds
 5. Check connections
 6. Check environment
- B. Drive Power-up and Commissioning:
 1. Measure Incoming Power Phase-to-Phase and Phase-to-Ground
 2. Measure DC Bus Voltage
 3. Measure AC Current Unloaded and Loaded
 4. Measure Output Voltage Phase-to-Phase and Phase-to-Ground
 5. Verify input reference signal
- C. All measurements shall be recorded.
- D. Drive shall be tuned for system operation.
- E. Drive parameter listing shall be provided.

3.04 TRAINING

- A. Manufacturer to provide a quantity of (1) (4)-hour sessions of on-site instruction.
- B. The instruction shall include the operational and maintenance requirements of the variable frequency drive.
- C. The basis of the training shall be the variable frequency drive, the engineered drawings and the user manual. At a minimum, the training shall:
 - 1. Review the engineered drawings identifying the components shown on the drawings.
 - 2. Review starting / stopping and speed control options for the controller.
 - 3. Review operation of the Human Interface Module for programming and monitoring of the variable frequency drive.
 - 4. Review the maintenance requirements of the variable frequency drive.
 - 5. Review safety concerns with operating the variable frequency drive.

END OF SECTION

Collier County Public Utilities Division SCADA Standards

Section 1.5

PLC - Allen Bradley

Revision 1.4



Contents

Section	Page
1.0 Field.....	1-1
1.5 PLC – Allen Bradley.....	1-1
1.5.1 Introduction.....	1-1
1.5.1.1 Purpose.....	1-1
1.5.1.2 Target Audience	1-1
1.5.1.3 Package System Suppliers.....	1-1
1.5.2 Hardware Standards.....	1-1
1.5.2.1 General.....	1-1
1.5.2.2 Controller Selection.....	1-2
1.5.2.3 Power Supplies.....	1-2
1.5.2.4 Host Communications.....	1-2
1.5.3 CompactLogix System Components	1-2
1.5.3.1 1769-L33 (L3) controller with modular IO.....	1-3
1.5.3.2 1769 Expansion Input/output limits.....	1-3
1.5.3.3 Standard 1769 Expansion Input/output Modules	1-3
1.5.3.4 Communication modules.....	1-3
1.5.4 ControlLogix System Component.....	1-3
1.5.4.1 CPU Modules.....	1-3
1.5.4.2 Communications Modules.....	1-3
1.5.4.3 Input/Output Modules.....	1-3
1.6 PLC Software Standards.....	1-4
1.7 PLC Software Development.....	1-4
1.7.1 Program Structure	1-4
1.7.2 IO Configuration	1-4
1.7.3 CompactLogix IO Modules.....	1-6
1.7.3.1 DeviceNet Card Configuration – CompactLogix	1-6
1.7.3.2 Analog Input Card Configuration – CompactLogix	1-6
1.7.3.3 Analog Output Card Configuration – CompactLogix.....	1-7
1.7.3.4 Digital Input Card Configuration – CompactLogix.....	1-8
1.7.3.5 Digital Output Card Configuration – CompactLogix.....	1-8
1.7.4 ControlLogix IO Modules	1-9
1.7.4.1 Ethernet Card Configuration – ControlLogix	1-9
1.7.4.2 Analog Input Card Configuration – ControlLogix	1-9
1.7.4.3 Analog Output Card Configuration – ControlLogix	1-10
1.7.4.4 Digital Input Card Configuration – ControlLogix	1-11
1.7.4.5 Digital Output Card Configuration – ControlLogix	1-11
1.7.5 PLC Tag Database	1-12
1.7.5.1 Controller Scope and Program Scope	1-12
1.7.5.2 Base Tags and Alias Tags	1-13
1.7.5.3 Produced Tags and Consumed Tags.....	1-14

1.7.6	PLC Control Code	1-14
1.7.6.1	Tasks	1-15
1.7.6.2	Programs	1-16
1.7.6.3	Routines	1-16
1.8	Naming Conventions	1-1
1.8.1	PLC Naming Conventions	1-1
1.8.1.1	PLC File and Controller Names	1-1
1.8.1.2	PLC Hardware Names (Communication and IO modules) 1-1	
1.8.1.3	Continuous Task Name	1-2
1.8.1.4	Periodic Task Names	1-2
1.8.1.5	Routine Names	1-3
1.8.2	PLC Software Tagging Criteria	1-3
1.8.2.1	Tagging Overview	1-3
1.8.2.2	Tag Naming Format	1-3
1.9	User-Defined Elements	1-1
1.9.1	General	1-1
1.9.1.1	User Data Type	1-1
1.9.2	Add-On Instructions	1-4
1.10	PLC Program Documentation	1-1
1.10.1	Routine Documentation	1-1
1.10.2	Tag Descriptions	1-1
1.11	PLC Program Development	1-1
1.11.1	General	1-1
1.11.2	Tags and Data	1-2
1.11.2.1	Analog Input Data	1-4
1.11.2.2	Messaging Data between PLCs	1-4
1.11.2.3	Standard Program Structure	1-5
1.12	PLC Programming Best Practices	1-6
1.12.1	Simplify Rungs of Code	1-6
1.12.2	Data Types	1-3
1.12.3	Prefacing Conditions	1-3
1.12.4	Discrete Controls	1-4
1.12.5	Equations	1-4
1.12.6	Timers	1-4
1.12.7	Counters	1-5
1.12.8	Button Control	1-5
1.12.9	Sequence Control	1-6
1.12.10	PID Control	1-6
1.12.11	SCADA Setpoints	1-6
1.12.12	Alarming	1-8
1.13	Glossary	1-1
Appendix A: Add On Instructions		1-1
Appendix B: Sample PLC Program		1-1
Appendix C: IP Address Table		1-1

Appendix D: Messaged Data Mapping.....	1-1
Appendix E: ControlNet Node Assignments	1-1
Appendix F: DeviceNet Node Addresses.....	1-1

Tables

TABLE 4-1 Approved UDT	1-3
TABLE 4-2 Approved Add-On Instructions	Error! Bookmark not defined.

Figures

Figure 2-1 Sample IO Configuration.....	1-6
Figure 2-2 Sample Program Configuration.....	1-15
Figure 4-1 Sample Non-optimized UDT Configuration	1-2
Figure 4-2 Sample Optimized UDT Configuration	1-2
Figure 4-3 Sample Tag	1-4
Figure 4-4 Access to Add-On Instructions.....	Error! Bookmark not defined.
Figure 5-1 Sample Ladder Routine	1-1
Figure 5-2. Sample Function Block Routine.....	Error! Bookmark not defined.
Figure 5-4 Sample Tag Descriptions and Tag Names	1-2
Figure 6-3. Analog Tag Aliased to Analog Input Card	1-4
Figure 7-1 Complicated Rungs of Ladder Code.....	1-2
Figure 7-2 Simplified Rungs of Ladder Code.....	1-3
Figure 7-3 Prefacing Conditions in Ladder.....	1-4
Figure 7-5 Counter Using CTU	1-5
Figure 7-6 Counter Using ADD.....	1-5
Figure 7-7 Two-State Toggle Control.....	1-6
Figure 7-8 Sample SCADA Setpoints.....	1-8
Figure 7-9 Sample Alarm Cascading Interlock.....	1-8

Acronyms and Abbreviations

A/M	auto/manual
A-B	Allen-Bradley
AI	analog input
AO	analog output
AOI	Add-On Instruction
BOOL	Boolean
cfm	cubic feet per minute
CPR	Coordinated Product Release
CPT	compute block
CV	control variable
DI	discrete input
DINT	double integer – 32 bits
DO	discrete output
FB	function block
ft ³ /minute	cubic feet per minute
FVNR	full-voltage non-reversing
FVR	full-voltage reversing
gph	gallons per hour
gpm	gallons per minute
GUI	graphical user interface
HMI	human-machine interface
INT	integer – 16 bits
IO	Input/Output
JSR	jump to subroutine command
LAD	ladder
mgd	million gallons per day
MSG	message commands
NOP	No Operation Command
ODVA	Open DeviceNet Vendors Association

PCS	Process Control System
PID	Proportional Integral Derivative
P&ID	process and instrumentation diagram
PLC	programmable logic controller
PV	process variable
RTH	run time hours
SCADA	Supervisory Control and Data Acquisition
SFC	sequential function chart
SINT	single integer – 8 bits
SP	setpoint
ST	structured text
T&D	treatment and disposal
TBD	to be determined
UDT	User-defined Data Type
VSD	variable-speed drive

Rev	By	Modification	Date

1.0 Field

1.5 PLC – Allen Bradley

1.5.1 Introduction

1.5.1.1 Purpose

The purpose of this document is to establish Collier County enterprise-wide programmable logic controller (PLC) program standards as applied to plant control systems utilizing Allen-Bradley (AB) ControlLogix and CompactLogix hardware. Hardware and software standards are needed to provide uniformity across multiple control system projects. Specific goals include:

- Provide a common structure and program development methodology for all PLC programs
- Define standards for PLC program development as applied to A-B ControlLogix and CompactLogix hardware platforms.
- Reduce installation and maintenance of both PLC and human-machine interface (HMI) programs thus reducing the Collier County operating expenses and capital expenditures.

For further reference and additional information, please refer to the following documents.

- *3.8 Alarming*
- *4.0 Tagging Standards*

1.5.1.2 Target Audience

It is expected that users of this document will have a general knowledge of PLC based control systems and a working knowledge of the AB ControlLogix and CompactLogix hardware platforms. In addition, users should have a working knowledge of Ethernet IP, ControlNet communications, DeviceNet communications including their configuration and operation as well as the general knowledge of the County wide SCADA system.

1.5.1.3 Package System Suppliers

Packaged system that include a PLC must also comply with these standards.

1.5.2 Hardware Standards

1.5.2.1 General

The Collier County control system is based on the Allen Bradley series of PLCs for primary control. Field devices such as motors, valves, and instruments will interface to the control system through a series of IO racks. Field device interface can be hardwired between the field device and an IO module, providing individual equipment signals per wire set or signals can be networked between field devices and a communication module providing for multiple equipment signals per wire set.

The actual modules used in a system shall be based upon the project specific design and specifications. Any deviation from the following listed components must be approved by Collier County prior to being used.

All modules will have firmware set to most current revision number that is compatible with existing systems. Ensure all software revisions and patch levels are at the same level throughout the integrated system.

1.5.2.2 Controller Selection

CompactLogix unless – IO count > 14 IO Cards or Memory requirements > 1.5 MB

ControlLogix for locations where CompactLogix is not used.

1.5.2.3 Power Supplies

All power supplies to be 24VDC

1.5.2.4 Host Communications

The system will use several modes of communication over the SCADA network to achieve the required system functionality, including the following in order of preference:

- **Ethernet IP Communications:** The preferred communication protocol is Ethernet. The Ethernet network will provide the connection between PLCs and the supervisory control and data acquisition (SCADA) system. In addition, PLC-to-PLC communications will primarily use the Ethernet network.
- **DF1 Communications:** Serial or DF1 communication will be used to support existing radios where Ethernet is not an option.
- **MODBUS TCP:** Used for stations to communicate to third party equipment such as DFS, GEN Sets, etc.

1.5.3 CompactLogix System Components

The CompactLogix PLC platform is the preferred PLC for the County. The following selection chart shall be used to determine the model of PLC to use based on functionality.

	L33ER
Serial Communications required (Radio, etc)*	X
MODBUS TCP	X
Ethernet Communications	X
I/O limitations	X
3 or more 1769 expansion cards required	X

* Adapter card required

The CompactLogix L33ER is the preferred controller and should be used whenever possible. Exceptions to this controller require approval from Collier County.

1.5.3.1 1769-L33 (L3) controller with modular IO

All CompactLogix 5370 controllers provide the following functionality:

- Two EtherNet/IP ports
- One USB port
- Support for local expansion modules
- Control of local and distributed I/O modules
- Use of 1784-SD1 or 1784-SD2 Secure Digital (SD) card for nonvolatile memory
- A battery is no longer necessary because of the internal energy storage solution

Some CompactLogix 5370 controllers provide the following functionality:

- Built-in power supply
- Some combination of embedded digital, analog, and high-speed counter modules
- Access to DeviceNet networks

The specific catalog number will be selected based on the needs of the location and the limitations of the module.

1.5.3.2 1769 Expansion Input/output limits

The following limits apply to expansion module counts:

L33 – A total of 16 modules in up to three banks

1.5.3.3 Standard 1769 Expansion Input/output Modules

- DI: 1769-IQ16
- DO: 1769-OB16
- AI: 1769-IF8
- AI: 1769sc-IF4IH, Hart Isolated Analog Input
- AO: 1769sc-OF8C

1.5.3.4 Communication modules

1.5.4 ControlLogix System Component

ControlLogix PLCs will be used for large IO or centralized control locations which are too large to be handled by CompactLogix controllers or multi-process locations.

1.5.4.1 CPU Modules

- ControlLogix 5562, 1756-L7x, Firmware Version – latest supported

1.5.4.2 Communications Modules

- Ethernet (TCP/IP): 1756-EN2T/B, 1756-EN2F/B,
- DH-485: ProSoft technologies, MVI56-GSC

1.5.4.3 Input/Output Modules

- Discrete Input (DI): 1756-IA16I
- Discrete Input (DI): 1756-IA16

- Discrete Output (DO): 1756-OA16I
- Analog Input (AI): Hart: 1756-IF8IH
- Analog Output (AO): 1756-OF8IH

1.6 PLC Rockwell Software Standards

The following standard software packages are required to develop plant control system PLC programs and meet standards developed by Collier County.

Rockwell Automation – RSLogix5000/Studio5000

Version – latest

Studio5000 includes Free OIT dev for Specific PVP.

Rockwell Automation – ControlFlash

Version - latest

Rockwell Automation - AssetCenter

EDS Files/ Add On Profiles

How to Manage?

AMS plugin (for DTM devices: HART, Profibus, etc)

NOTE: ControlFlash software is used to flash the firmware revisions of ControlLogix and CompactLogix cards to the desired level. The latest firmware files can be found at: <http://support.rockwellautomation.com/ControlFlash/>. For ControlLogix, the processor flash firmware must be updated lock-step with the RSLogix 5000 version. For other modules, you only need to update the flash firmware if you want the new feature/functionality described in the release note. It is not recommend updating these other modules ahead of the programming software as it may not be compatible. The manual for using ControlFlash can be found at: http://literature.rockwellautomation.com/idc/groups/literature/documents/um/1756-um105_-en-e.pdf

1.7 PLC Software Development

1.7.1 Program Structure

An A-B Logix PLC program includes three main components, which work together to form the overall PLC program. The components of the PLC program include:

- IO configuration
- PLC program internal tag database
- Control code

1.7.2 IO Configuration

The IO configuration provides a map for the CPU to define modules (IO and communication) included in the control system as well as their locations within the system. The IO configuration also serves to tell the CPU what version of hardware is being used in the control system and to set the data transfer rate between the CPU and the modules. The

IO configuration is based on design documents created by the design Engineers for the control system. Design documents can include:

- Process and instrumentation diagram (P&IDs)
- Process control narratives
- Control system layout drawings
- IO list

Configuration of the system is done by the programmer at the start of system programming. Configuration entails selecting modules, placing modules in appropriate locations, providing suitable module names, and setting module parameters.

The sample configuration in Figure 2-1, Sample I/O Configuration, shows the CPU at slot [0] and includes a default indication of device type (1769-L33ER) and a programmer-assigned name (PBPS_Main). Remaining modules include communications and IO modules.

Card names must be unique within a project so a standardized naming approach should be used. For IO modules start with the name of the rack and include the slot number and IO card type to uniquely identify each card. See section 1.8.1.2 PLC Hardware Names (Communication and IO modules) for detailed guidelines.

For networked devices use the tag naming standard to assign a name to the device.

Organize I/O points in racks so that I/O from two or more pieces of equipment with the same process function are divided among at least two groups of I/O cards in a rack. Organize the I/O points so that if one I/O card fails, at least one piece of the equipment from the group that has the same process function will be fully operational.

The following sections detail the standard configuration settings for each major type of module based on the module types specified. Any deviations from the standard configuration must be approved by Collier County prior to system development.

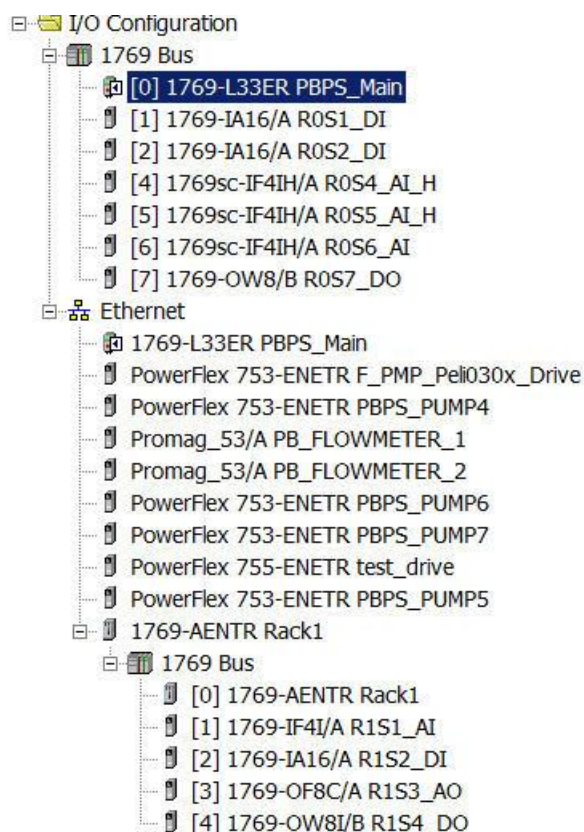


Figure 2-1 Sample IO Configuration

1.7.3 CompactLogix IO Modules

1.7.3.1 DeviceNet Card Configuration – CompactLogix

Each DeviceNet module will include the following configuration settings.

DeviceNet Card Configuration Settings	
General Tab	
Node	0
Revision	3
Electronic Keying	Compatible Keying
Input Size	90
Output Size	90
Connection Tab	
Requested Packet Interval	5 ms (Default – not configurable)
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked

1.7.3.2 Analog Input Card Configuration – CompactLogix

Each analog input module will include the following configuration settings.

Analog Input Card Configuration Settings	
General Tab	

Analog Input Card Configuration Settings	
Name	Set Appropriate Module Name
Electronic Keying	Compatible Module
Connection	Input (Default)
Data Format	Integer (Default)
Revision	1
Connection Tab	
Requested Packet Interval	Default (not configurable)
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Configuration Tab – All Channels	
RTS	Unchecked (default 100ms)
Channel Enable	As Required
Input Range	4 mA to 20 mA
Digital Filter	60 Hz
Data Format	Engineering Units
Scaling: Low Signal	4000
Scaling: High Signal	20000
Alarms – All Channels	
Disable Alarms	Checked
Latch Process Alarms	Not Checked

1.7.3.3 Analog Output Card Configuration – CompactLogix

Each analog output module will include the following configuration settings.

Analog Output Card Configuration Settings	
General Tab	
Name	Set Appropriate Module Name
Electronic Keying	Compatible Module
Connection	Output (Default)
Data Format	Integer (Default)
Revision	1
Connection Tab	
Requested Packet Interval	Default (not configurable)
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Configuration Tab – All Channels	
Channel Enable	As Required
Output Range	4 ma to 20 ma
Data Format	Engineering Units
Scaling: Low Signal	4000
Scaling: High Signal	20000
Hold For Initialization	Not Checked

Analog Output Card Configuration Settings	
Limits Tab – All Channels	
Latch Clamp Alarms	Not Checked
High Clamp	20000
Low Clamp	4000
Faults/Program Action – All Channels	
Fault Mode	Use Fault Value
Fault Value	4000
Fault Ramp	Not Checked
Program Mode	Use Fault Value
Program Value	4000
Program mode communication failure output state	Fault Mode

1.7.3.4 Digital Input Card Configuration – CompactLogix

Each digital input module will include the following configuration settings.

Digital Input Card Configuration Settings	
General Tab	
Name	Set Appropriate Module Name
Electronic Keying	Compatible Module
Connection	Output (Default)
Data Format	Integer (Default)
Revision	3
Connection Tab	
Requested Packet Interval	N/A
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Configuration Tab	
Enable Change of State: Off -> On	Not Checked
Enable Change of State: On -> Off	Not Checked
Input Filter Time: ALL	1 ms

1.7.3.5 Digital Output Card Configuration – CompactLogix

Each digital output module will include the following configuration settings.

Digital Output Card Configuration Settings	
General Tab	
Name	Set Appropriate Module Name
Electronic Keying	Compatible Module
Connection	Output (Default)
Data Format	Integer (Default)
Revision	3
Connection Tab	

Digital Output Card Configuration Settings	
General Tab	
Requested Packet Interval	N/A
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Configuration Tab	
Output State in Program Mode	Hold Last State
Output State in Fault Mode	Off (change as necessary based on equipment requirements)
Major Fault On Controller If...	Change outputs to Fault Mode state

1.7.4 ContrlLogix IO Modules

1.7.4.1 Ethernet Card Configuration – ControlLogix

Each Ethernet module will include the following configuration settings.

Ethernet Card Configuration Settings	
General Tab	
IP Address	As Assigned*
Revision	4
Electronic Keying	Compatible Keying
Connection Tab	
Requested Packet Interval	N/A
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked

1.7.4.2 Analog Input Card Configuration – ControlLogix

Each analog input module will include the following configuration settings.

Analog Input Card Configuration Settings	
General Tab (Module Definition)	
Series	A
Revision	1
Electronic Keying	Compatible Module
Connection	Data
Input Data	Analog and HART PV
Coordinated System Time	Time stamped
Data Formate	Float
Connection Tab	
Requested Packet Interval	100 ms
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Use Scheduled Connection...	Checked (If in Remote Rack)
Configuration Tab – All Channels	
RTS	100 ms

Analog Input Card Configuration Settings	
Module Filter [-3 db]	50 Hz
Enable HART	Checked for all HART Devices
Keep HART replies	15 Seconds
(HART) Pass Through	Once per Module Scan
Input Range	0 ma to 20 ma
Sensor Offset	0.0
Digital Filter	0
Scaling: High Signal	20000.0
Scaling: Low Signal	4000.0
Scaling: High Engineering	20000.0
Scaling: Low Engineering	4000.0
Calibration Tab	
Do not make changes to this tab unless fully versed in calibration procedures associated with the analog input module.	

1.7.4.3 Analog Output Card Configuration – ControlLogix

Each analog output module will include the following configuration settings.

Hold last values should be considered on a case by case basis.

Analog Output Card Configuration Settings	
General Tab	
Comm Format	Float Data
Revision	1
Electronic Keying	Compatible Keying
Connection Tab	
Requested Packet Interval	100 ms
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Use Scheduled Connection...	Checked (If in Remote Rack)
Configuration Tab – All Channels	
Output Range	0 ma to 20 ma
Sensor Offset	0.0
Hold for Initiation	As required
Scaling: High Signal	20000.0
Scaling: Low Signal	4000.0
Scaling: High Engineering	20000.0
Scaling: Low Engineering	4000.0
Output State Tab – All Channels	
Output State in Program Mode	Hold Last State
Output State in Fault Mode	Hold Last State
Communications Failure	Change outputs to Fault Mode state
Limits Tab – All Channels	
Disable All Alarms	Checked
Latch Limit Alarms	Not Checked
High Clamp	100
Low Clamp	0

Analog Output Card Configuration Settings	
Ramp in Run Mode	Not Checked
Calibration Tab	
Do not make changes to this tab unless fully versed in calibration procedures associated with the analog output module.	

1.7.4.4 Digital Input Card Configuration – ControlLogix

Each digital input module will include the following configuration settings.

Digital Input Card Configuration Settings	
General Tab	
Comm Format	Input Data (If in Local Rack) Rack Optimized (If in Remote Rack)
Revision	3
Electronic Keying	Compatible Keying
Connection Tab	
Requested Packet Interval	100 ms if Local Rack, N/A if Remote Rack
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Configuration Tab	
Enable Change of State: Off -> On	Not Checked
Enable Change of State: On -> Off	Not Checked
Input Filter Time: ALL	1 ms

1.7.4.5 Digital Output Card Configuration – ControlLogix

Each digital output module will include the following configuration settings.

Hold last values should be considered on a case by case basis.

Digital Output Card Configuration Settings	
General Tab	
Comm Format	Output Data (If in Local Rack) Rack Optimized (If in Remote Rack)
Revision	3
Electronic Keying	Compatible Keying
Connection Tab	
Requested Packet Interval	100 ms if Local Rack, N/A if Remote Rack
Inhibit Module	Not Checked
Major Fault On Controller If...	Not Checked
Configuration Tab	
Output State in Program Mode	Hold Last State
Output State in Fault Mode	Off (change as necessary based on equipment requirements)
Major Fault On Controller If...	Change outputs to Fault Mode state

1.7.5 PLC Tag Database

The tag database is used to define storage locations within the PLC for data used in the processing of control code. The tag database is created from a number of sources including the PLC IO configuration documents and the physical device IO list design documents. When the PLC's IO configuration is developed (based on standards outlined in Section 2.2), the PLC creates default database tags to define storage locations for data received from and sent to control modules. Default tag names for these locations do not lend themselves easily to use through the PLC program. Therefore, a standard programming procedure is used to create additional tags, which better define the intended purpose or data source. After creation of the additional tags, the default data is mapped to the better defined data locations. For input data (discrete and analog inputs), this has the added benefit of ensuring that inputs maintain a consistent state for one entire program cycle scan. This also creates a single point of change if the IO point was identified incorrectly or needs to be relocated.

The IO list, which is created as part of the control system design, provides a list of physical devices connected to the control system. Some devices, such as transmitters, are hard-wired to IO modules. Other devices, such as motor starters, can be connected through a communications network such as Ethernet. Database tags are created for these field devices to define storage locations for their data.

With the exception of the default tags for IO modules, all other tags in the database are created manually by the programmer. Utilizing the import/export capabilities of the RSLogix programming environment, the time needed to configure the tag database can be reduced through the use of spreadsheet applications such as Microsoft Excel™.

1.7.5.1 Controller Scope and Program Scope

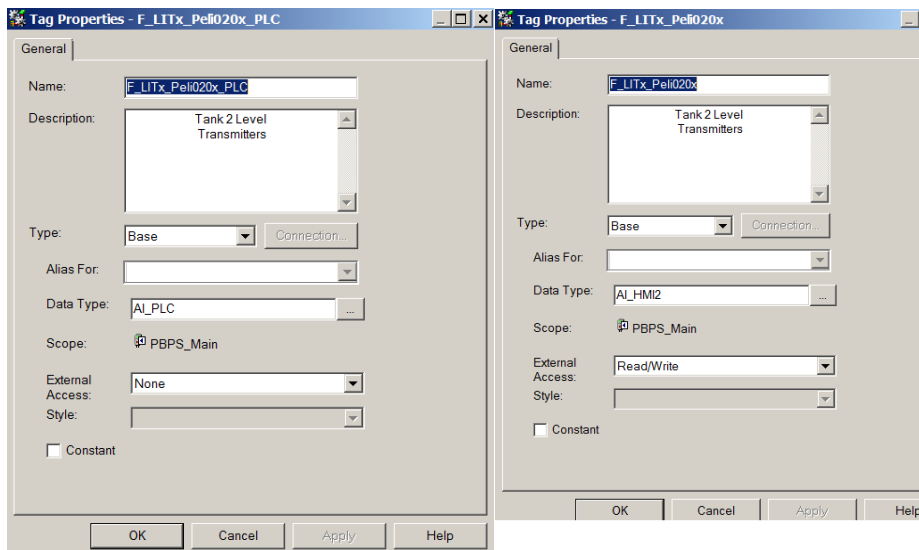
PLC Tags can be controller scoped or program scoped. Controller-scoped tags are configured such that they are accessible by all parts of the control program as well as being accessible to applications outside of the PLC, such as SCADA/HMI systems.

Program-scoped tags are configured within a separate data memory area associated with a program. Within the PLC program they are only accessible by the program in which they are configured. This allows for the ability to use a common tag name multiple times across a number of separate programs. This can find use when applying standardized control code across multiple programs.

Program-scoped tags can be accessed by applications outside of the PLC program (such as an HMI application). However, this practice is not allowed on Collier County control systems.

For data dedicated to transfer to/from an external application, such as the SCADA/HMI systems, either individual tags or user-defined data type (UDT) controller scoped tags may be used. If a UDT tag is used, it should only contain data that is normally used by the external application.

Only tags that contain data needed by external applications should be set to external access. This is to minimize data traffic, security risks and to prevent all tags in a controller from being pulled into an OPC server.



1.7.5.2 Base Tags and Alias Tags

RSLogix5000 allows for the creation of two primary types of data tags including base tags and alias tags. A base tag defines an actual area of CPU memory and is the primary data storage identifier for a given piece of information. Configuration of this type of tag includes data types such as integer, real, bool, timer, counter, etc. Base tags can be configured as a single point or as an array, and they can also be configured with a user data type (UDT).

An alias tag is used to reference the CPU memory location defined by another tag without utilizing another block of memory of similar size. An alias tag may refer to a base tag or to another alias tag. An alias tag may also reference a specific point within a larger structured tag. An example of this would be referencing a single bit within an integer, referencing a specific integer within an integer array, or referencing an element within a UDT. Alias tags allow for the creation of tag names that better identify a purpose without the need to consume excessive memory in the CPU.

In general, where an alias tag has been created, the alias tag (and not the base tag) should be used for all control programming in the PLC. This requirement is to be followed to reduce the risk of writing conflicting commands to registers. There are, however, some instances where it is appropriate to use the base tag for control, an example of which is the zeroing of all registers in an array. Special care should be taken in these instances to prevent overwriting critical data.

Where alias tags are used, tag descriptions are to be linked to the alias tag and not the base tag.

RSLogix uses a minimum of 32 bits in the creation of a base tag. Therefore, creating a base tag that uses less than 32 bits of data will result in unusable CPU memory space. Integer (INT), Single Integer (SINT), and Boolean (BOOL) data types use 16 bits, 8 bits, and 1 bit respectively. Therefore, these three data types are not to be used in the configuration of a base tag. A more efficient use of space is to create data arrays (single tag with multiple elements) of integer (INT), single-integer (SINT), or double-integer (DINT) type. Alias tags can then be created, which point to elements within the array. For integer data, an integer data array

with an even-numbered array size should be used. For single-integer arrays, the array size should be in multiples of four. For Boolean data, double-integer arrays should be used.

1.7.5.3 Produced Tags and Consumed Tags

Finally, tags can be configured as produced or consumed rather than as base or alias. A produced tag is intended for transmission across a network such that it is available to be read by other controllers. Produced tags are always controller scoped. Consumed tags are configured to be read from a network connection. The local controller is the consumer, and the remote controller is the producer. Like produced tags, consumed tags are always at the controller-scope level.

A produced tag uses one network connection at a CPU, and only a limited number of connections are available in any CPU. Because of this, where data from one PLC is needed by another PLC over a network connection, non-cached message commands (MSG) will be used to read data between PLCs. In order to avoid overwriting local control commands in a receiving PLC, *write* messages shall not be used.

1.7.6 PLC Control Code

The control code is the heart of the PLC program and relies on both the IO configuration and the tag database for operation. In the RSLogix 5000 programming environment, each control program is organized into tasks, programs, and routines, as shown in Figure 2-2, Sample Program Configuration.

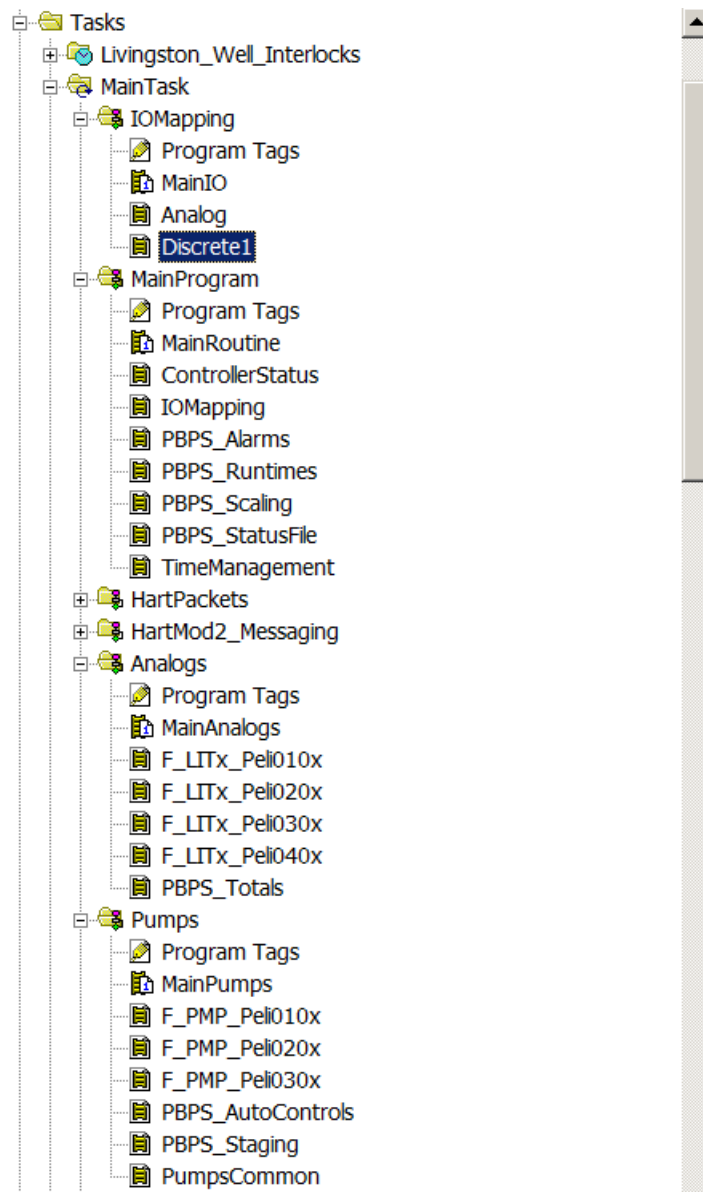


Figure 2-2 Sample Program Configuration

1.7.6.1 Tasks

Tasks occupy the highest level of organization in the program structure and can be continuous, periodic, or event-driven. All tasks, except for the single continuous task, can be assigned a priority level from 1 to 15, with 1 being the highest priority level. If two tasks are triggered at the same time, the task with the higher priority will execute first. If two tasks with the same priority are triggered at the same time, the controller switches between the two tasks every millisecond. The continuous task runs at a fixed priority lower than all other tasks in the controller.

A continuous task is one that runs continuously (i.e., in the background), through all its assigned programs, unless interrupted by another task. All CPU time not allocated to other operations (such as communications, periodic, or event-driven tasks) is used to execute the

programs within the continuous task. Once the continuous task completes a full execution scan, an update of outputs is triggered at which time the scan immediately starts over at the top. A continuous task is created automatically upon creation of a new control program. For Collier County control systems, the continuous task will form the basis of the control program. A ControlLogix PLC program can contain multiple tasks; however, only one continuous task is allowed in any ControlLogix program.

Periodic tasks are designed to run at preset time intervals ranging from 0.1 milliseconds to 2,000,000 milliseconds. Periodic tasks perform a function according to a specific rate. When the end of a specified time period is reached, the task is triggered. When triggered, the task interrupts any lower priority task (continuous, periodic, or event-driven), and all programs assigned to the task are executed or scanned once, from top to bottom. After this single scan, an output update is triggered, and control is returned to the task that was interrupted at the point at which it was interrupted. Multiple periodic tasks may exist on a controller, where each task is configured to operate at independent rates.

An event-driven task is a task that performs a specific function when triggered by a specified event. When the event-driven task is triggered, it interrupts any lower priority tasks, executes one time, and returns control to the task that was interrupted at the point at which it was interrupted.

An event-driven task can be triggered by any of the following.

- Change of state of a digital input
- A new sample of analog data
- A consumed tag
- An event instruction
- Various motion control operations

1.7.6.2 Programs

Within a task, and serving as the next layer down in the organization structure, is the program. Each program contains its own program-scoped tag database (local data table), a main executable routine, and optionally several subroutines. You can also specify an optional fault routine for each program. The program-specific fault routine is executed if the controller encounters an instruction-execution fault within any of the routines in the associated program.

To execute the routines within a program when a program is triggered, at least one routine must be configured as the main routine. This is done within the properties dialog box of the program configuration. For the Collier County PLC programs, each program will include one routine with a common name containing *Main*. Each *Main* routine will be configured as the main routine for that program. This routine will then be used to call all other routines within that program using the *Jump to Subroutine* (JSR) command. Parameters within the JSR command shall not be used for Collier County PLC programs.

1.7.6.3 Routines

Routines are the base of the control structure and incorporate the actual program control code. Each program within a task is expected to include a number of routines to better organize the controls for equipment.

The RSLogix5000 programming environment includes the ability to program routines in one of four IEC-61131 standard languages, including ladder (LAD), function block (FB), sequential function chart (SFC), and structured text (ST). Due to the difficulties associated with troubleshooting structured text, this programming language should not be used for programming any Collier County systems except within AOIs. SFC finds use in machine control where a defined repetitive sequence is required. Therefore, the applicability of SFC is limited for a process-intensive application.

The two main programming languages to be utilized for the Collier County control programs will be ladder and function block. Due to the operations available, discrete (or Boolean) logic is best served through the use of ladder code. Function block on the other hand, allows for a large section of code to be viewed simultaneously, leading to easier troubleshooting. An FB, as applied by Rockwell Software, serves as a data tag and hence utilizes more CPU memory than functions used in the ladder programming environment. Therefore, line for line, a routine programmed in ladder will use less memory space in the CPU than a routine programmed in FB. As a result, it may be advantageous (though not mandatory) to configure routines using the ladder programming language.

1.8 Naming Conventions

1.8.1 PLC Naming Conventions

Collier County requires that new PLC programming be coded using Rockwell Automation's RSLogix 5000 software. In the RSLogix 5000 programming environment, ControlLogix projects are broken down into tasks, programs, and routines. These software components and other specific subcomponents of the software need to have names applied, which uniquely identify them.

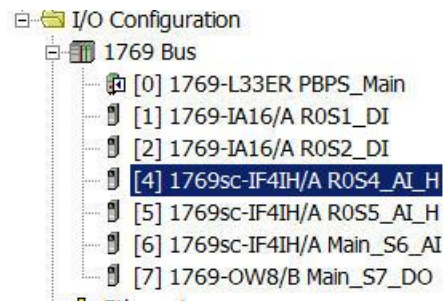
1.8.1.1 PLC File and Controller Names

The RSLogix 5000 PLC file names and the ControlLogix controller names should follow tagging standards.

Refer to *Control System Tagging Standards* document for a listing of the tag numbering components.

1.8.1.2 PLC Hardware Names (Communication and IO modules)

Communication and IO modules added to a PLC configuration require unique names. The names assigned to communications and IO modules should provide an indication of module type, rack location, and slot location. These names should align themselves with information associated with facility loop databases. For communication and IO modules, the following syntax should be used.



Remote racks will be sequentially named Rack1 - Rackx

RxSyy_AA

Rx	Rack Number (0-9)
Syy	Slot Number (0 - 16)
AA	Module Type (DI, DO, AI, AO, EN, CN, DN, MB, SR)
_H	Hart suffix modifier for AI and AO

where DI = Discrete Input
DO = Discrete Output
AI = Analog Input
AO = Analog Output
EN = Ethernet Communications
CN = ControlNet Communications
DN = DeviceNet Communications
MB = Modbus Communications

SR = Serial Communications
 HC = High Speed Counter
 PI = Pulse Input

Example 1: R0S6_DI; Discrete input module in main rack, slot 06

Example 2: R2S3_DI; Discrete input module in remote rack 2, slot 03

Example 3: R0S1_EN; Ethernet communications module in main rack, slot 01

1.8.1.3 Continuous Task Name

Within a ControlLogix PLC program, only one continuous task can be configured and it will be called Common. This task will contain common code for all controllers such PLC Clock logic, PLC Status logic and common messaging or communication logic.

1.8.1.4 Periodic Task Names

The PLC program should be divided into logical program groups depending on the size and complexity of the program. For small processes (booster station) it may be more beneficial to group like equipment together into one program while in larger process (RO) it would make more sense to have programs based on process area.

Periodic tasks will be used to separate and organize code into manageable sections. Task names should be such that the function of the task is shown. Each ControlLogix PLC program will have one ProcessCommon periodic task.

- Process Common Programs:
 - IOMapping – Program used to Map data from IO Card tags to and from internal PLC Tags. This Program will contain separate routines for Analog, Discrete and other type of IO interfaces such as Hart.
 - Analog – Program used for scaling all analog inputs. This program will contain a routine for each analog input as well as a totalization routine.
 - Miscellaneous Alarms – Program to contain alarm routines that are not directly related to a specific process area.

All logic should be broken up into Process Specific Periodic tasks based on the facility and complexity of the process. Within each Process Task there will be typical Programs for the various equipment and logic.

- Process Specific Programs
 - XXXX_Pumps
 - XXXX_Valves
 - XXXX_Alarms
 - XXXX_Auto

1.8.1.5 Routine Names

Routines should be given a name representative of the logic they execute. Every program will contain one main routine used to call all other subroutines in that program utilizing a series of JSR instruction. The main routine will simply be called *MainRoutine*. Routines will be listed in the tree alphabetically but will be executed based on the order they are called in the *MainRoutine*'s JSR instructions. For Equipment Routines the base tagname of the device should be used as the name of the Routine.

1.8.2 PLC Software Tagging Criteria

1.8.2.1 Tagging Overview

The tagging scheme is designed to be as simple as possible and still provide adequate capability to uniquely identify each control system loop.

1.8.2.2 Tagnamming Format

Refer to *4.0 Tagnamming* document for a listing of the tag standards. In addition to the tag standards some additional guidelines shall be followed in the PLC tag structure.

- When possible user defined tags (UDTs) should be used to group tags together that relate to a specific device or function.
- Keep the base tag for all UDTs the same for a particular device the same. Use suffixes where needed to differentiate different tags or UDTs related to the same device or function.
 - _PLC for PLC UDT objects
- If additional tags are required that are not containing in a base UDT; consult with Collier County to determine if the tag should be added to the UDT or kept as a unique tag object.

1.9 User-Defined Elements

1.9.1 General

The RSLogix version of controllers allows for two types of user defined functions. These functions provide the ability for the programmer to create more efficiently organized programs with increased standardization.

1.9.1.1 User Data Type

The UDT is a custom data type (similar to an integer or real data type) that is created by the programmer. A UDT will usually incorporate a collection of tags of various data types into a single defined entity. An element in a UDT can be assigned any data type currently available in the CPU including that of another UDT. Once created, a UDT is available as a data type option available when creating database tags. Therefore, when a new tag is created in the tag database, the new tag can be assigned a UDT data type in the same way that it would be assigned an integer or real data type. The newly created tag of data type UDT will include all the elements of the UDT, which will show up as elements of the base tag (*Base_Tag.element*).

A consideration when creating a new UDT is that the processor uses memory based on the order used within the definition of the structure. The next 2 examples show two structures that have the exact same members, but the 1st example does not group data members of the same type consecutively and the second example does. Example #1 uses 32 bytes (256 bits or 16 words) of memory, Example #2 uses only 20 bytes (160 bits or 10 words), in other words, example #2 uses 60% less memory than example #1 just because it is grouped properly in the UDT. It is also important to note that the processor sets aside memory to optimize communication with SCADA. This means that there is actually a double impact if the UDTs are not set up properly.

The exception to grouping data structures according to data type occurs when you need to set up a UDT to match a particular system variable from the PLC status file. In these cases the UDT should be setup to match the data format presented in the user manuals. Member names for these UDTs should match the examples in order to allow the easiest troubleshooting.

Structure Name: EXAMPLE1

NAME	Data Type	Description
BOOL1	BOOL	1st BOOL
INT1	INT	1st INTEGER
BOOL2	BOOL	2nd BOOL
INT2	INT	2nd INTEGER
BOOL3	BOOL	3rd BOOL
TIMER	TIMER	Internal Timer

BOOL4	BOOL	4th BOOL
INT3	INT	3rd INTEGER
BOOL5	BOOL	5th BOOL

Figure 4-1 Sample Non-optimized UDT Configuration

Structure Name: EXAMPLE2

NAME	Data Type	Description
TIMER	TIMER	Internal Timer
BOOL1	BOOL	1st BOOL
BOOL2	BOOL	2nd BOOL
BOOL3	BOOL	3rd BOOL
BOOL4	BOOL	4th BOOL
BOOL5	BOOL	5th BOOL
INT1	INT	1st INTEGER
INT2	INT	2nd INTEGER
INT3	INT	3rd INTEGER

Figure 4-2 Sample Optimized UDT Configuration

User-defined data types, or structures, will be set up based on the Add On Instruction (reference next section for details) that is to be used and will encompass all of the SCADA interface points required for the template. Each member of the structure is referenced using an extension name. The structure is then assigned as a data type for a PLC tag. The program then references each member in the following format "TAG.NAME." where TAG is the PLC tag, or address, and NAME is the element within the user-defined data structure.

For Collier County projects, UDTs are created to serve one of two main purposes. A UDT can be created to fill a specific task such as reading the date and time from the CPU. A UDT can also be designed to work with specific equipment such as motor starters or field devices.

Data created to work with specific equipment types may be split into two UDTs. One UDT designed to handle all PLC internal data. The other equipment-specific UDT designed to provide an interface to the HMI. Separating UDT data into internal data and HMI data simplifies the tasks associated with creating the HMI applications as well as preventing unnecessary data from being passed between a PLC and HMI.

UDTs designed for interfacing to SCADA/HMI systems will not include any additional identifier in the UDT name. UDTs designed for internal PLC use will include an additional "_PLC" identifier at the end of the UDT name.

Table 4-1 lists HMI specific UDTs created for Collier County PLC programs. Additional UDTs will be added as Collier County projects evolve.

TABLE 4-1
Approved UDT

UDT Name	UDT Purpose	Description and Functions
AI_HMI	Analog Input Scaling and Alarming data for external use	Analog input scaling, analog alarming, analog alarm setpoint adjustment, test mode selection, alarm disable mode selection, and calibration mode selection
AI_HMI2	Analog Input Scaling and Alarming data for external use	Redundant Analog input scaling, analog alarming, analog alarm setpoint adjustment, test mode selection, alarm disable mode selection, and calibration mode selection
AI_PLC	Analog Input PLC internal data tags.	
CS_HMI	Constant Speed Motor Data Block for external use	Standard constant speed motor data block
CS_PLC	Constant Speed Motor Data Block for internal use. Includes PlantPax add on defined tags as well	Standard Adjustable speed motor block utilizing the PF755 Plant PAX object
AS_HMI	Adjustable Speed Motor Data Block for external use	Standard Adjustable speed motor block utilizing the PF755 Plant PAX object
AS_PLC	Adjustable Speed Motor Data Block for internal use. Includes PlantPax add on defined tags as well	Standard Adjustable speed motor block utilizing the PF755 Plant PAX object
MOV_HMI	Modulating Valve Data Block	Modulating valve data block including valve position indication (percent), fail alarm, and A/M selection and control
MOV_PLC	Modulating Valve Data Block	Modulating valve data block including valve position indication (percent), fail alarm, and A/M selection and control

Figure 4-3 shows sample tag F_LITx_Peli030x. The tag is configured with a data type of AI_HMI (analog input). As shown, the tag includes a number of elements which are a mix of real and Boolean data types. Every tag that is assigned a data type of AI_HMI will include the same set of tag elements.

F_LITx_Peli030x		AL_HMI	Diesel Tank 1 Level
F_LITx_Peli030x.aOor		BOOL	Diesel Tank 1 Level Out of Range Alarm
F_LITx_Peli030x.aAlm		BOOL	Diesel Tank 1 Level Common Alarm
F_LITx_Peli030x.aHi		BOOL	Diesel Tank 1 Level High Alarm
F_LITx_Peli030x.aLo		BOOL	Diesel Tank 1 Level Low Alarm
F_LITx_Peli030x.aHiHi		BOOL	Diesel Tank 1 Level High High Alarm
F_LITx_Peli030x.aLoLo		BOOL	Diesel Tank 1 Level Low Low Alarm
F_LITx_Peli030x.aNoChg		BOOL	Diesel Tank 1 Level No Change Alarm
F_LITx_Peli030x.sOos		BOOL	Diesel Tank 1 Level Out of Service
F_LITx_Peli030x.sHiEnable		BOOL	Diesel Tank 1 Level Hi Alarm Enabled (HMI)
F_LITx_Peli030x.sHiHiEnable		BOOL	Diesel Tank 1 Level HiHi Alarm Enabled (HMI)
F_LITx_Peli030x.sLoEnable		BOOL	Diesel Tank 1 Level Lo Alarm Enabled (HMI)
F_LITx_Peli030x.sLoLoEnable		BOOL	Diesel Tank 1 Level LoLo Alarm Enabled (HMI)
F_LITx_Peli030x.sNoChgDsbl		BOOL	Diesel Tank 1 Level No Change Alarm Disabled
F_LITx_Peli030x.cNoChgDsbl		BOOL	Diesel Tank 1 Level No Change Alarm Disabled
F_LITx_Peli030x.cNoChgEnbl		BOOL	Diesel Tank 1 Level No Change Alarm Enabled
F_LITx_Peli030x.cRstAlm		BOOL	Diesel Tank 1 Level Alarm Reset
F_LITx_Peli030x.cOutSvc		BOOL	Diesel Tank 1 Level Out for Service Command
F_LITx_Peli030x.cInSvc		BOOL	Diesel Tank 1 Level In Service Command
F_LITx_Peli030x.sPvA		REAL	Diesel Tank 1 Level Process Value A
F_LITx_Peli030x.sHiEu		REAL	Diesel Tank 1 Level High Engineering Units
F_LITx_Peli030x.sLoEu		REAL	Diesel Tank 1 Level Low Engineering Units
F_LITx_Peli030x.sTtlTdy		REAL	Diesel Tank 1 Level Today's Flow Total
F_LITx_Peli030x.sTtlYst		REAL	Diesel Tank 1 Level Yesterday's flow total
F_LITx_Peli030x.sTtl		REAL	Diesel Tank 1 Level All-time flow total
F_LITx_Peli030x.sAvgTdy		REAL	Diesel Tank 1 Level Today's average
F_LITx_Peli030x.sAvgYst		REAL	Diesel Tank 1 Level Yesterday's average
F_LITx_Peli030x.cHiSp		REAL	Diesel Tank 1 Level High Alarm Setpoint
F_LITx_Peli030x.cLoSp		REAL	Diesel Tank 1 Level Low Alarm Setpoint
F_LITx_Peli030x.cHiTmr		REAL	Diesel Tank 1 Level High Alarm Delay Timer
F_LITx_Peli030x.cLoTmr		REAL	Diesel Tank 1 Level Low Alarm Delay Timer
F_LITx_Peli030x.cNoChgTmr		REAL	Diesel Tank 1 Level No Change Alarm Delay Timer

Figure 4-3 Sample Tag

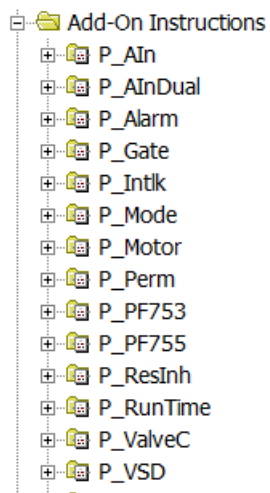
1.9.2 Add-On Instructions

The AOI is a custom-designed control element created by the programmer to incorporate PLC code designed for a specific task. The AOI is then applied, as a standard programming element, during PLC programming. AOIs are best applied to programming tasks requiring repetitive standardized code such as analog input scaling or analog alarm generation.

For Collier County PLC programs, an AOI can be created using ladder or FB. Once created, an AOI becomes a standard programming element accessed during PLC code creation in the same manner as other programming elements such as timers/counters or computational elements.

In general Rockwell software PlantPax AOIs should be used unless otherwise approved. Below is a list of standard PlantPax AOIs.

For detailed description of a particular AOI, refer to the specific guideline document developed for that AOI.



1.10 PLC Program Documentation

All control programs created for Collier County need to include a minimum level of documentation integrated into the control code. This documentation is required to allow others, besides the original programmer, to understand the operation and functionality of the control code. This documentation is critical during the commissioning process and for future maintenance requirements.

Program documentation needs to describe individual control routines, to describe individual data tags, and to track changes to control code for maintenance purposes.

1.10.1 Routine Documentation

Sufficient documentation within each routine should be included to adequately describe the functionality for each section of code, how the section of code works, and what variables affect the logic.

For a routine programmed using ladder, the first rung in the ladder file should use the No operation Command (NOP) instruction with a description of the purpose of the routine. Additional NOP rungs should be added, where appropriate, to separate the ladder routine into logical blocks, with each NOP rung providing a description of the purpose of the given section of code. Finally, individual rungs of PLC code should be documented, where required, to clarify complex code such as lengthy calculations, jump routines, or index-addressed code.

Figure 5-1 shows a sample ladder routine with typical documentation.

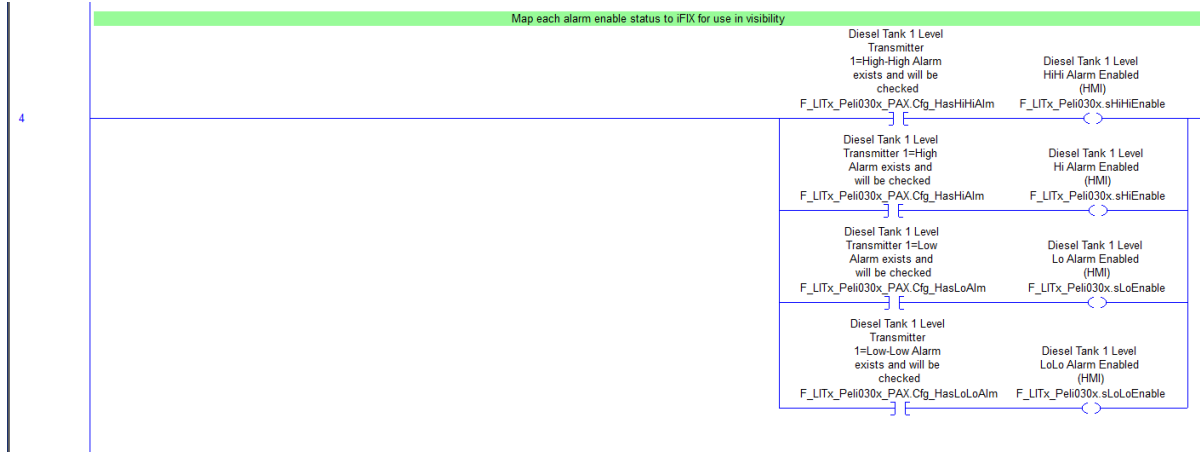


Figure 5-1 Sample Ladder Routine

1.10.2 Tag Descriptions

Every data tag utilized in control code should include a description outlining the purpose of the data. This description is in addition to the tag name. To allow for standardization across all programs, all programmers working on Collier County programs should configure their software to limit OMI tag descriptions to a width of 13 characters. Where at all possible, tag descriptions should be limited to four lines. Helpful tag description information includes the purpose of the tag (control or status), associated equipment, equipment numbers,

engineering units, or applicable ranges. For discrete tags, additional useful information includes the function of the tag in the 0 and/or 1 state.

The intent is to provide additional useful information beyond the tag name to allow for easy understanding of the tag's purpose. As with data tags, the shorthand list of symbol components can be used to efficiently provide important information for tag descriptions.

Figure 5-4 shows sample tag descriptions and tag names.

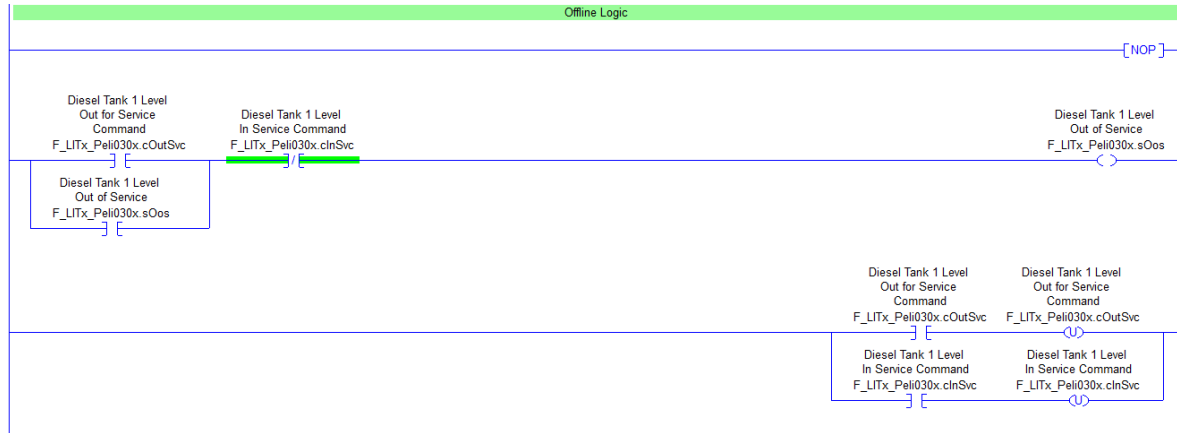


Figure 5-4 Sample Tag Descriptions and Tag Names

1.11 PLC Program Development

One key objective for PLC program development is to provide a program structure that is easy for O&M staff to understand and troubleshoot. A PLC program is built once and then adapted to changing operational needs for years. Defining PLC programming standards will make the PLC programs easier to understand and will reduce operating costs for Collier County, allowing for a more sustainable system.

Creation of a new control program requires a basic understanding of the control system requirements and selected hardware. The ControlLogix CPU part number and firmware version should be known at the outset of program creation. With this information and a preliminary IO layout, a new control program can be started.

Once a new program has been started, the steps required to program a fully functioning control program include:

- Verify IO list based on P&IDs, submittals or other documentation
- Create add-on elements (UDT and AOIs)
 - Import from standards files
- Add IO configuration (IO racks, IO modules, etc.)
- Create preliminary tag database for field devices
- Configure basic program structure (tasks and programs)
- Add standard routines (Overhead, System Monitoring, etc.)
 - Import from standards files
- Add recurring code using UDTs and AOIs
 - Analog Scaling
 - Analog Alarms
- Add detail control code
- Add initialization, fault handling, and power-up routines

All RSLogix5000-based programs will be configured based on the common standards listed below. A standard template/example PLC program file shall be provided by Collier County, containing all necessary elements, including but not limited to the following: AOI's, UDT's, program structure and standard logic used in all PLCs.

1.11.1 General

This section lists standards to be implemented in the creation or modification of any Collier County facility PLC programs.

- All control code that is to be continuously scanned through the main continuous task will be separated into logical programs within the main task.
 - Programs will be based on unit processes
- Each program within a task will include one main routine that will be used to call all other routines within a program.
 - No control code other than routine calls (JSR) will be included in a main routine.

- All main routines will be named *MainRoutine*
- Routines can be programmed in IEC 61131 compliant ladder, FB, or SFC.
 - Structured text will not be allowed unless specific approval is granted by Collier County.
 - Function Block routines will use a D sheet size (22 by 34 inches) set to landscape mode.
- An overhead routine (to be included in the overhead program within the main task) is to be included. This routine is used to provide standard code not affiliated with any specific process area and which may be used throughout the remainder of the PLC program. Such code may include (but is not limited to):
 - continuous timers for general program use
 - PID control timer(s)
 - Provide a daily roll over bit
- All programs will include an initialization routine.
 - This routine is separate from any power-up or fault handling routines.
 - This routine will be used to set hard-coded and default setpoints as well as to initialize or reset sequence controls.
 - Activation of initialization routines will be from manually toggled bits. No automatic initialization should be included to prevent accidental overwriting of existing configurations.
- A control system monitoring routine is to be included in the overhead project. This routine will include PLC code which will:
 - Read the time and date from the CPU
 - Retrieve the CPU run/remote/program status
 - Retrieve the CPU key switch position
 - Retrieve the maximum and last scan times
 - Retrieve the major and minor fault bits
 - Retrieve the fault status from applicable IO cards controlled by the CPU
- All PLC to PLC communications will be configured using Produced/Consumed tag arrays.

1.11.2 Tags and Data

This section lists standards to be implemented in the creation or modification of tags or data for any Collier County PLC programs.

- Tag descriptions will be included for all data tags used in PLC control code.
 - The control program tags and descriptions will be configured per Sections 4 and 5 of this document as well as the *Tagging Standards Document*.
- Separate tags will be configured for status and control functions to/from all HMI units.
 - Where possible, UDTs dedicated to HMI data should be used.

- Boolean data type is not allowed for base tags.
 - A minimum of one double-integer array should be created to allow for the use of Boolean tags in the PLC program.
 - Actual tags used in the control program will be aliased to bits within the double integer array as required.
- Integer data types are not allowed for base tags
 - A minimum of one integer array should be created to allow for the use of Integer tags in the PLC program.
 - Array size will be in multiples of 2 registers (for example, array size 2, 4, 6, 8).
 - Actual integer tags used in the control program will be aliased to the integer array as required.
- Single-integer data types are not allowed for base tags.
 - Where necessary, one single-integer array will be created to allow for the use of integer tags in the PLC program.
 - Array size will be in multiples of 4 registers (for example, array size 4, 8, 12, 16).
 - Actual single-integer tags used in the control program will be aliased to the single-integer array, as required.
- Indexed addressing is not allowed for equipment control.
 - Indexed addressing may be utilized for noncritical functions such as data transfer to/from the HMI if approved by Collier County.
 - In cases where indexed addressing is used, sufficient documentation must be included in the program to clearly describe the functioning of the code and all addressing associated with the code.
- UDTs are allowed.
 - A library of approved UDTs will be provided as part of a Collier County standard sample PLC program.
 - Additional UDTs can be used if approved by Collier County prior to implementation.
- AOIs not specifically noted elsewhere in this document or detailed in Collier County AOI Detail documents, are allowed if approved by Collier County prior to implementation.
 - Any AOI created outside of Collier County control must allow access to the source code. Locking or password protecting of AOIs is not allowed.

1.11.2.1 Analog Input Data

- Scaling of analog inputs to engineering units will be done using PLC code based on a standard AOI. Aside from the scaling routine, all PLC logic shall use the scaled engineering unit values.
 - Scaling of analog inputs to engineering units will not be done in the IO cards.
 - High-High, High, Low, and Low-Low analog alarms will be provided for each analog input using a standard AOI.
- Create one routine for each analog input module to provide scaling for each channel within an analog input module.
- For each analog input, alias the instrument tag to the appropriate analog input module element.
 - Example: For level transmitter 97LIT00200 physically terminated in Rack 01, Slot 02, Channel 00, Figure 6-3 shows analog tag `_9700200_Level` aliased to the first input (channel 00) of the analog input card.

Name	△ Base Tag	Data Type	Style	Description
<code>_9700200_Level</code>	<code>R01S00_CN:2:1.Ch0Data</code>	REAL	Float	Influent Wetwell Level 0 - 15 Ft
<code>97LIT00200</code>		INT		HMI (SCADA) Communications PID Control

Figure 6-3. Analog Tag Aliased to Analog Input Card

1.11.2.2 Messaging Data between PLCs

- Data required from a different PLC shall be obtained by doing data reads. Data writes are not to be used at any time.
- To reduce system overhead and reduce network traffic, all data shall be packed into arrays by the originating PLC, prior to being read. The READING PLC will break out the data array into individual elements for use by the program.
- Data shall be separated into REAL and INTEGER data arrays within the originating PLC and receiving PLC. Real data will use the Real data array with a length of 10 elements. INTEGER and BOOL data types will use the INTEGER array with a length of 20 elements.
- The data array names within a given PLC shall be based upon the name of the PLC and the data type.
 - Example: Real data stored in `_97PLC100` to be read by other PLCs:
 - REAL array in `_97PLC100` will be: `_97PLC100_Real`.
 - REAL array in `_57PLC100` will be: `_57PLC100_Real`.
- For BOOL data types, individual tags are mapped to bits within an INT word, which is part of the integer data array. This reduces the number of words required for communications. Within the integer data array a variable number of integers, located at the end of the array, will be dedicated to BOOL data. It is desirable to limit BOOL data as much as possible to limit unused bits in the system.
 - Example: Transfer of BOOL elements from `_97PLC100`
 - `_97PM00101.Remote` – Pump 1 Local Remote Hand Switch

- _97PMP00101.Failed - Pump 1 Fault Status
- _97PMP00101.Running - Pump 1 running status
- _97PMP00102.Remote - Pump 2 Local Remote Hand Switch
- _97PMP00102.Failed - Pump 2 Fault Status
- _97PMP00102.Running - Pump 2 running status
- The BOOLs in _97PLC100 can be mapped into INT elements as follows:
 - _97PM00101.Remote - _97PLC100_Int[0].0
 - _97PMP00101.Failed - _97PLC100_Int[0].1
 - _97PMP00101.Running - _97PLC100_Int[0].2
 - _97PM00102.Remote - _97PLC100_PLC_Int[1].0
 - _97PMP00102.Failed - _97PLC100_PLC_Int[1].1
 - _97PMP00102.Running - _97PLC100_PLC_Int[1].2

Refer to Appendix D for a listing of all Message Data mappings.

1.11.2.3 Standard Program Structure

All Logix programs shall be based on the tasks, programs, and routines structure indicated below.

- Main Task (continuous - Common)
 - Overhead Program (P01_Overhead)
 - Main Routine (R00_MainRoutine)
 - Overhead Routine (R01_Overhead)
 - Control System Monitoring Routine (R02_System_Stat)
 - I/O module Status Monitoring Routine (R03_IO_Card_Monitoring)
 - DeviceNet Network Monitoring Routine (R03_DNET_Stat)
 - Input Data Map Program (P02_Input_Scaling)
 - Main Routine (R00_MainRoutine)
 - Analog Scaling Routine 1 (R10_AI_Card1)
 - Analog Scaling Routine 2 (R11_AI_Card2)
 - Analog Scaling Routine 3 (R12_AI_Card3)
 - Unit Process 1 Code Program (P10_UnitAreaName)
 - Main Routine (R00_MainRoutine)
 - Routine 1 Sub-process 1 controls (R01_SubProcessName)
 - Routine 2 Sub-process 2 controls (R02_SubProcessName)
 - Routine 3 Sub-process 3 controls (R03_SubProcessName)
 - Program Initialization Routine (R99_Initialize)
 - Unit Process 2 Code Program (P11_UnitAreaName)
 - Main Routine (R00_MainRoutine)
 - Routine 1 Sub-process 1 controls (R01_SubProcessName)
 - Routine 2 Sub-process 2 controls (R02_SubProcessName)
 - Routine 3 Sub-process 3 controls (R03_SubProcessName)

- Communications Program (P91_Communications)
 - Main Routine (R00_MainRoutine)
 - Communications 1 Routine (PLC_x/PLC_a messages) (R01_PLCa)
 - Communications 2 Routine (PLC_x/PLC_b messages) (R02_PLCb)
 - Communications 3 Routine (Other communications such as Modbus or Serial if required)
 - Initialization Program (P99_System_Initialize)
 - Main Routine (R00_MainRoutine)
- Periodic Task 1 (T01_Cmplnce_5000ms)
 - Compliance (P02_Cmplnce)
 - Main Routine (R00_MainRoutine)
 - Compliance control code (R01_Compliance)
 - PIDs (P10_UnitAreaName)
 - Main Routine (R00_MainRoutine)
 - Compliance control code (R01_process_PID)
- Periodic Task 2 (Txx_description_xxMS; where applicable)
- Event Task 1 (Txx_description; where applicable)
- Event Task 2 (Txx_description; where applicable)
- Etc.
- Unscheduled Programs/Phases
 - Revision Control Program
 - Revision Document 1
 - Revision Document 2
 - Temporary Ladder Routine For Code Development
 - Temporary Function Block Routine For Code Development

1.12 PLC Programming Best Practices

When creating a PLC program, there are numerous paths to the same result. There is no right or wrong way to program a PLC. Only what works and what does not. As such, some specific practices result in a better developed PLC program, with “better” being a relative term and having numerous shades of grey. This section sets out to document various “Best Practices” which should be used when developing PLC programs for Collier County.

1.12.1 Simplify Rungs of Code

For ladder routines, avoid long complicated rungs of code (Figure 7-1).

- Break up a complicated rung of code into smaller parts.
- Avoid excessive branching in a single rung of code.
- Use a single rung comment at the beginning of the group to explain what you are doing (Figure 7-2).

Avoid this...

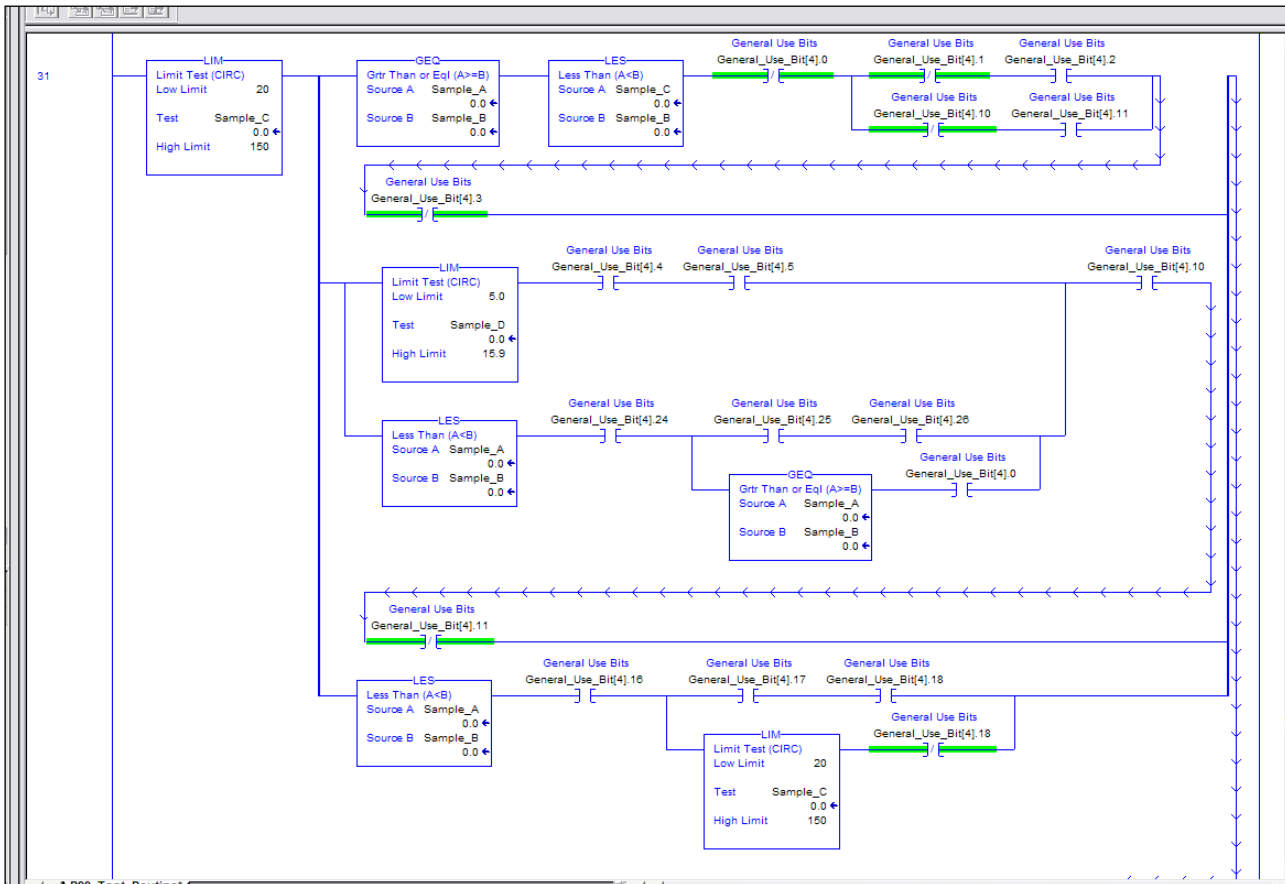


Figure 7-1 Complicated Rungs of Ladder Code

Try using this instead...

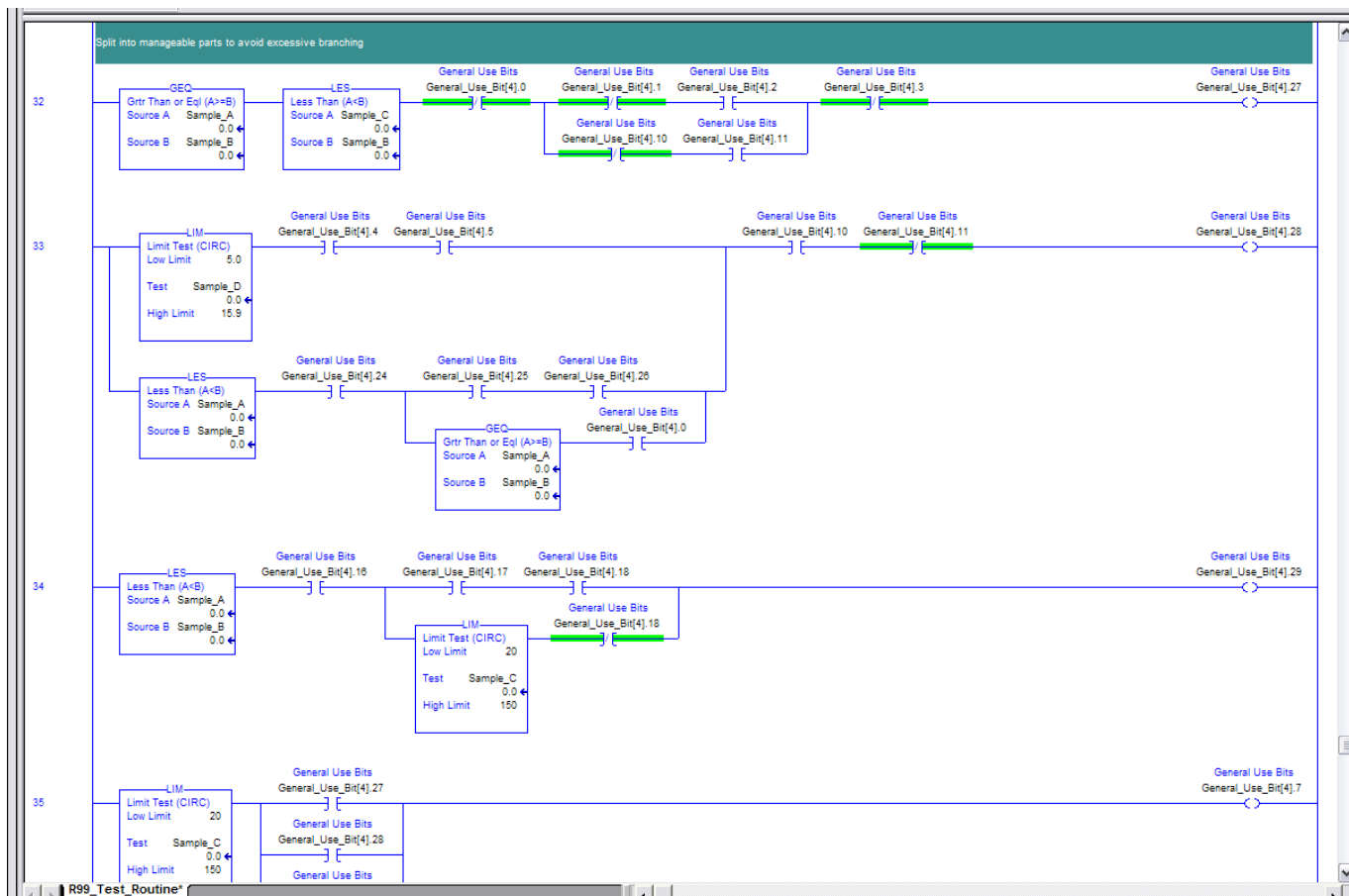


Figure 7-2 Simplified Rungs of Ladder Code

1.12.2 Data Types

Use a data type appropriate for the information being manipulated.

- The RSLogix5000 software is configured to select a default data type (usually DINT).
- Maintain consistency throughout the PLC program for given functions keeping in mind:
 - DINT Range: -2147483648 to 2147483647
 - INT Range: -32768 to 32767
 - SINT Range: -127 to 128

1.12.3 Prefacing Conditions

When prefacing an output with test or condition, apply a test or condition to each line.

- Do not rely on a default condition on the first branch with conditional test on the second branch.
- Apply conditional test to each branch
- In Figure 7-3 below, Rung 26 is not the preferred method, Rung 27 is the preferred method

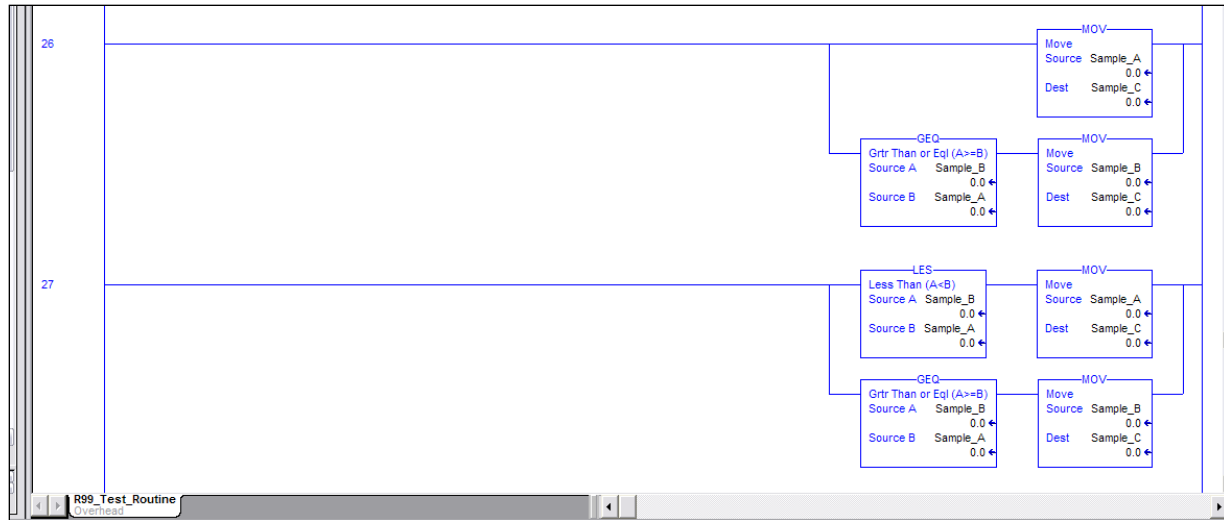


Figure 7-3 Prefacing Conditions in Ladder

1.12.4 Discrete Controls

Discrete controls include the functions OTE (output Energize), OTL (output Latch), OTU (Output Unlatch). Where possible, utilize the OTE function for discrete control. The OTL and OTU pairs should not be overused where the OTE can provide the same functionality.

1.12.5 Equations

Long, complicated equations (such as in chemical dosing) should be split into smaller calculations where feasible. The compute block (CPT) is useful, but equations can get a bit long and hard to follow. Splitting calculations into smaller parts with subtotals allows for easier verification of calculations during commissioning.

ADD, SUB, MUL, DIV use less memory than CPT; therefore, with easy, simple calculations avoid using the CPT block.

1.12.6 Timers

- Timer setpoints from HMI should be in required units (hour, minutes, seconds).
- If seconds only then PLC should be configured to convert seconds to milliseconds (ms) for input to timer setpoint (MUL to convert seconds to ms).
- If setpoint requires minutes and seconds, use separate tags for minutes and seconds (including separate tags for setpoint feedback). Combine times in PLC code if applicable using appropriate logic.
 - For example, if hours and minutes are required for the setpoint inputs, the programmer can convert hours to minutes then add the minutes setpoint to provide total time setpoint.
- Where called for, include countdown logic to provide an indication of the time remaining to the activation of specified function.

- Time remaining should utilize same format as time setpoint including separate tags for hours or minutes as required.

1.12.7 Counters

Counters can be done in different ways. One option is to use a counter block (CTU or CTD) (Figure 7-5). Another is to use an ADD block (Figure 7-6).

- CTU/CTD provides additional status information.
- ADD uses less memory.
- No preferred method. Just be consistent within a section of code (routine or program).

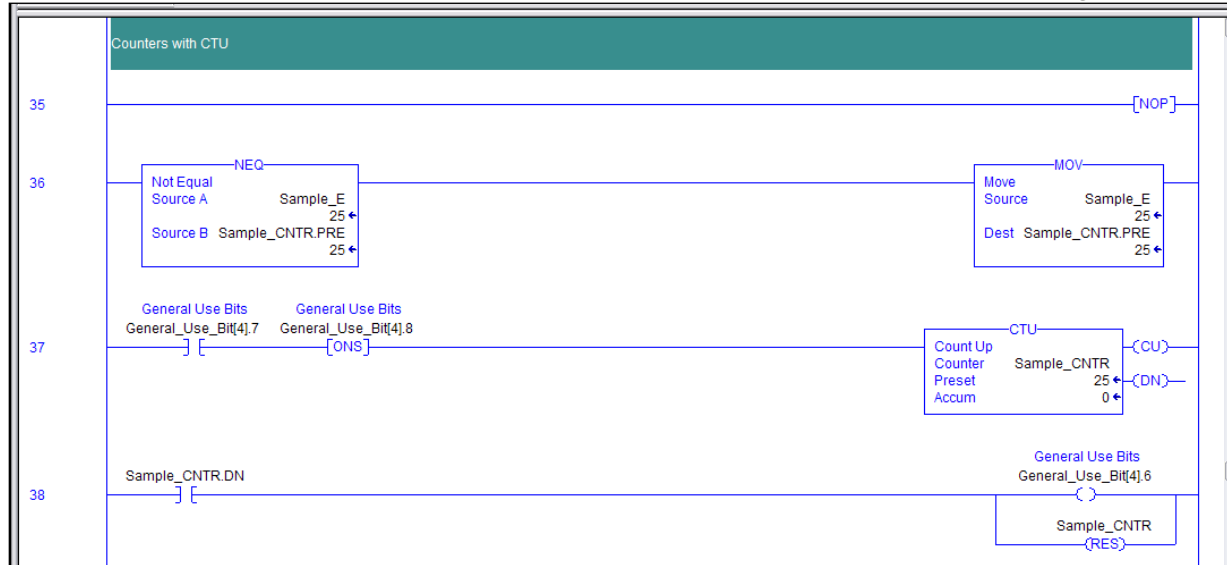


Figure 7-5 Counter Using CTU

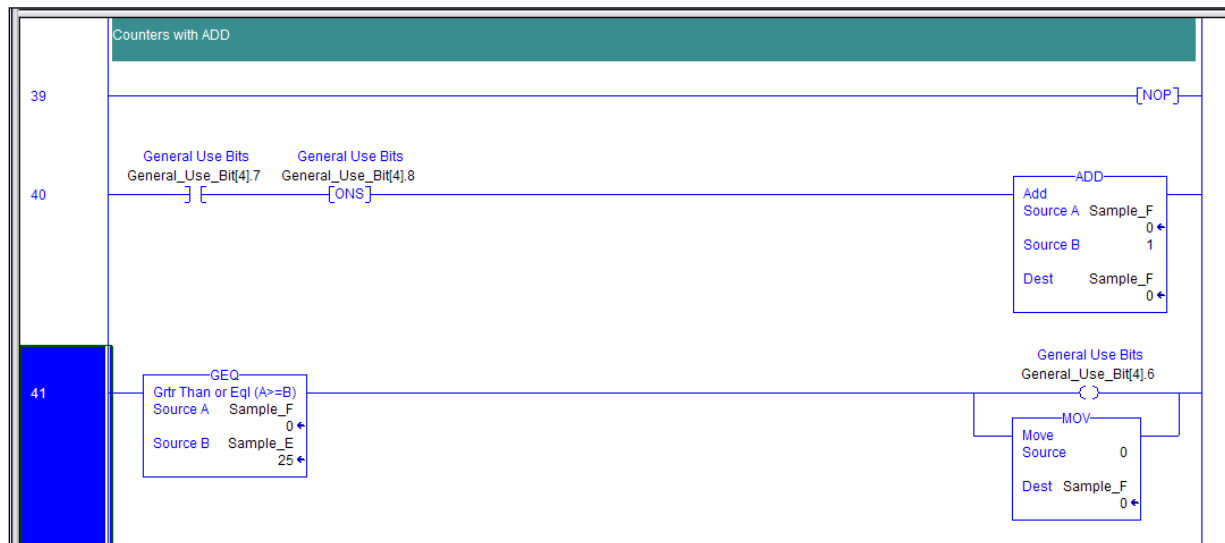


Figure 7-6 Counter Using ADD

1.12.8 Button Control

A three bit toggle control method using two command bits with feedback, shown in Figure 7-7.

- Can be used for auto/manual selection and feedback.
- Provides for positive control confirmation:
 - If control from SCADA configured to use momentary command, it is possible for the PLC to miss the command. This logic eliminates this possibility.
- Requires button action on SCADA using Set Tag to 1 type action
- Separates status feedback for use in PLC code and for status display on SCADA.

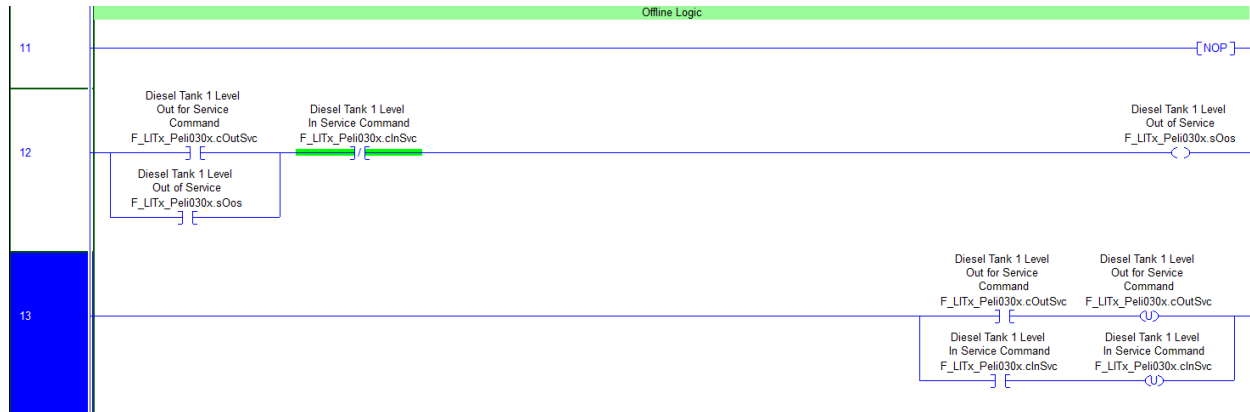


Figure 7-7 Three Bit Toggle Control

1.12.9 Sequence Control

Sequence control is any group of control actions in which the result of one action (step) initiates an adjacent action (step + 1), normally applied to sequences of more than two steps.

- Sequence Indication and Control
 - For every sequence-controlled operation, the PLC should be configured to include a sequence reset button in case a sequence hangs up.
 - For every sequence controller, PLC should include a *sequence fail* alarm indication.
 - For every sequence controller, PLC should include a *sequence step* indication.
 - Step indication of data type SINT or INT
 - Do not use data type real for sequence step indication

1.12.10 PID Control

- PIDs configured to use independent tuning parameters
- PIDs are not to be programmed within process control routines under the main continuous task and but rather as separate periodic tasks

1.12.11 SCADA Setpoints

PLC should be configured to verify that setpoint is within allowable range (see sample code in Figure 7-8).

- If setpoint is greater than maximum allowable, move max to setpoint
- If setpoint is less than minimum allowable, move min to setpoint
- Finally, move setpoint to required location

Use a separate feedback tag for setpoint inputs. Indicate on HMI.

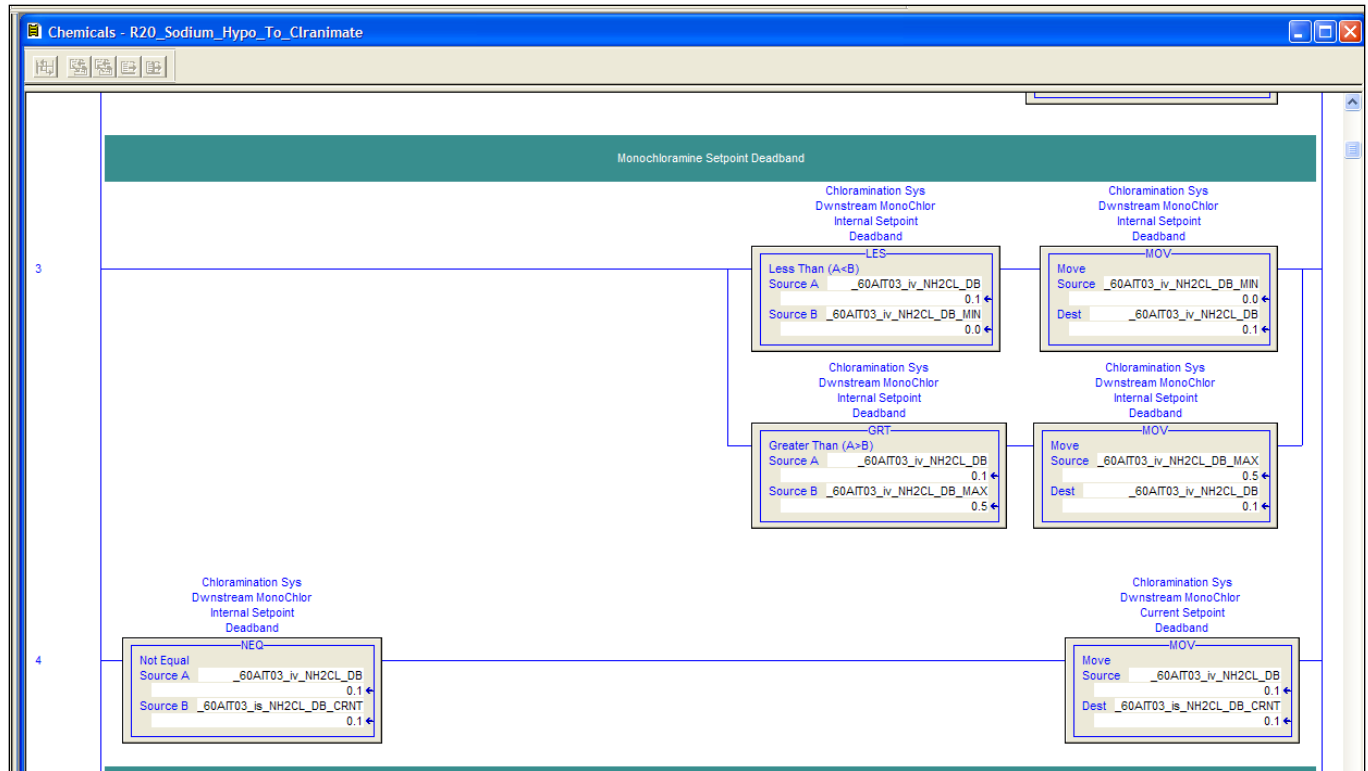


Figure 7-8 Sample SCADA Setpoints

1.12.12 Alarming

Whenever possible, alarms should be interlocked to reduce the number of cascading alarms. For example, a motor high temperature alarm will cause the motor to stop running, but should not create a motor fail alarm. These cascading alarms can lead to overwhelming the HMI with alarms because of a single failure. For example, a power failure generates an alarm at the HMI. But, when the power fails, all of the motors will stop running, causing many alarms to be sent to the HMI.

This can be achieved using different techniques. One technique (using relay ladder logic) is to add a normally closed (XIO) relay contact from the High Temperature alarm in series with the motor fail alarm coil. See Figure 7-9 for a sample.

Reference standard 3.8 Alarming for additional alarming guidelines.



Figure 7-9 Sample Alarm Cascading Interlock

1.13 Glossary

AOI	Add-On Instruction – Reusable PLC programming instruction, created by the programmer, to provide specific control functions or features
Back Plane	Interfaced used to pass data into and out of modules. The backplane can be physical (ControlLogix IO rack) or virtual (CompactLogix, which does not include a separate IO rack)
Base Rack	IO rack containing a PLC. May or may not include IO modules
CPR	Coordinated Product Release – Term used by Rockwell Software to define a suite of software and hardware firmware levels tested by Rockwell Software and certified to work together. For Collier County control system projects all software used and hardware firmware will be CPR9 compliant.
CTD	down counter
CTU	up counter
Event Instruction	The EVENT instruction is used to trigger one execution of an event task.
Event Task	A task that performs a specific function when triggered by a specified event. When the event task is triggered, it interrupts any lower priority tasks, executes one time, and returns control to the task that was interrupted, at the point at which it was interrupted.
human-machine interface	An open architecture operator interface that is configured using object technology
Input/Output	External signals interfaced to the PLC control system. Can be hard wired or networked from physical devices (transmitters, motors, etc) or software applications (HMI, Historian Data Collector, Etc)
IO Module	Input or Output module, installed within an IO Rack, used to provide a hardwired interface to field devices such as transmitters or motors
IO Rack	For modular-based PLC control system, the IO Rack is the base structure used to house the various modules making up the PLC control system
programmable logic controller	A modular microprocessor-based hardware device designed to monitor field device control signals, evaluate programmed logic based on field device signals, and provide appropriate output signals to control equipment for facility operation.
Remote IO	IO modules contained within a remote rack

Remote Rack	IO rack not containing a PLC, but which interfaces to a PLC via a network connection
UDT	User Data Type created by the programmer containing single or multiple data elements of various types.

Appendix A: Add On Instructions

Appendix B: Sample PLC Program

Appendix C: IP Address Table

Appendix D: Messaged Data Mapping

Appendix E: ControlNet Node Assignments

Appendix F: DeviceNet Node Addresses

Collier County Public Utilities Division SCADA Standards

Section 1.7

Control Panels

Revision 1.3



Contents

1.0 **Field..... 1**

 1.7 Control Panels..... 1

 1.7.1 Introduction..... 1

 1.7.2 Common Features 1

 1.7.3 Drawings and Documentation 2

 1.7.4 Environmental Requirements..... 3

 1.7.5 Panel Construction..... 3

 1.7.6 Electrical Requirements..... 9

Rev	By	Modification	Date
1.2	CH2MHILL	Renamed File to remove MCC	4/29/2016
1.2	CH2MHILL	Added "Use lockable deadfront for all control panels unless otherwise noted. All switches and control elements to be mounted on deadfront with no exterior door penetrations for lights, switches, buttons or display units." to section 1.7.2.2	4/29/2016
1.2	CH2MHILL	Added Modification Table	4/29/2016
1.3	MWR	Added din rail mounted UPS	2/2/2022

1.0 Field

1.7 Control Panels

1.7.1 Introduction

1.7.1.1 Purpose

The purpose of this document is to establish Collier County enterprise-wide standards for the various control panels utilized throughout the Utility. Specific goals include:

- Provide a common manufacturer and specific part for each of the various devices.
- Reduce installation, troubleshooting and maintenance by reducing the number of variations.

For further reference and additional information, please refer to the following documents.

- *4.0 Tagging Standards*

1.7.1.2 Target Audience

It is expected that users of this document will have a general knowledge of panel designs and working with electrical equipment.

1.7.1.3 Definitions

A. Abbreviations:

1. FDT: Factory Demonstration Test.
2. HMI: Human-Machine Interface.
3. HVAC: Heating, Ventilating, and Air Conditioning.
4. I&C: Instrumentation and Control.
5. I/O: Input and Output.
6. O&M: Operation and Maintenance.
7. P&ID: Process and Instrument Diagram.
8. PC: Personal Computer.
9. PIC: Process Instrumentation and Control.
10. PLC: Programmable Logic Controller.
11. SCADA: Supervisory Control and Data Acquisition.

B. Enclosure: Panel, Control Panel, Console, Cabinet, or Instrument Housing.

1.7.2 Common Features

1.7.2.1 All Panels

- A. Control panels to only be powered by 120VAC circuits. Voltages above 240 VAC shall be located in a separate enclosure.
- B. The use of 120VAC circuits should be minimized and 24 VDC power and devices should be used when possible.

1.7.2.2 Outdoor/Wet Panels

- A. Provide 316 stainless steel Weathershed NEMA 4X enclosures for outdoor and wet well applications powder coated white.
- B. The panel shall have sun shields installed on all sides with welded 1.5 - 2" standoffs and coated to match the corresponding panel.
- C. Install outdoor panels to minimize direct sun light on the front.
- D. All panel entries shall be at the bottom using water tight conduit fittings/Meyers hubs or approved equal.
- E. Schedule 80 PVC conduits shall be used
- F. Use lockable deadfront for all control panels unless otherwise noted. All switches and control elements to be mounted on deadfront with no exterior door penetrations for lights, switches, buttons or display units.
- G. Mounting bolts or tabs should be welded to panel to minimize water intrusion points

1.7.2.3 Indoor Panels

- A. Provide NEMA 12 enclosures for dry, indoor, and non-corrosive environment applications.

1.7.2.4 PLC/Control Panels

- A. Provide panels with 24VDC uninterruptible power supplies. Minimum 10-minute back-up power for a fully loaded control panel.
 - 1. UPS shall be din rail mounted Ethernet I/P capable with Allen Bradley AOP.
 - 2. UPS shall be rated to maintain panel UL rating.
 - 3. Design basis: Phoenix Contact Quint Series
- B. All equipment required to communicate to the SCADA system that a station has a power failure has occurred will have back-up power.
- C. Provide enclosures with intrusion switches that activate upon opening the door.
- D. Provide fold down shelf on the outside of the deadfront door or the inside of the outer door for locations where there is no deadfront.
 - 1. Provide all doors with a door stop to hold the door in the open position to prevent a panel door from closing when the shelf is open.

1.7.3 Drawings and Documentation

All panels will be provided with the following drawings and documentation:

-
- A. Dimensional layout drawn to scale in inches. This should show all components as well as the spacing between components.
 - B. Electrical drawings
 - C. Bill of Material showing each component part number or ordering information.
 - D. For panels that include a PLC
 - 1. IO List in excel format
 - 2. Loop drawings showing the complete circuit from the field device to the IO card with each wire and terminal identified.

1.7.4 Environmental Requirements

- A. In high moisture locations a dehumidifier will be added to the cabinet with a Hygrostat Relative Air Humidity Switch for control of the dehumidifier.
- B. Panels shall be installed above the flood elevation.

1.7.5 Panel Construction

1.7.5.1 General Requirements

- A. Provide structural reinforcements within enclosures to insure a plane surface, to limit vibration and to provide rigidity during shipment, installation and operation without distortion or damage to the panel or to any instrument.
- B. Cut, punch, or drill cutouts for face-of-panel mounted instruments and smoothly finish with rounded edges.
- C. Panel backplanes will be of the same type metal as the panel.
- D. Provide a print pocket within enclosures. Keep a current copy of drawings in the pocket.
- E. Mount equipment in a manner to facilitate removal and maintenance after installation.
- F. No water piping or tubing to be located inside control panels.
- G. No fuses to be used, instead use appropriately sized circuit breakers.
- H. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.
 - 1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals".
 - 2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.
- I. Like Equipment Items:
 - 1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
 - 2. Implement same or similar functions in same or similar manner.

1.7.5.2 Fabrication

A. General:

1. Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.
2. Fabricate panels, install instruments, wire, and plumb, at the factory.
3. Factory Assembly: Assemble panels at the manufacturer's factory. No fabrication other than correction of minor defects or minor transit damage shall be done on panels at Site.
4. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

B. Wiring Within PIC Panels:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Abrasion protection for wire bundles which pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
 - i) Locking-fork-tongue or ring-tongue lugs.
 - ii) Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
 - iii) Wires terminated in a crimp lug, maximum of one.
 - iv) Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
 - i) Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 - ii) Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.
 - i) Plastic Wire Ducts Color:
 - a) White.
12. Provide a minimum of 2" of space from terminal blocks to Panduit.

C. Temperature Control:

1. General
 - i) Heat Shields: Provide white solar shields for all outdoor enclosures of the same material as the enclosure they are mounted.
 - a) Locate solar shields on all sides to not interfere with door operations or handles or any front mounted devices.

-
- b) Installed on all sides with welded 1.5 - 2" standoffs.
 - c) Include in heat load calculation for Air Conditioner sizing
 - 2. Freestanding Panels:
 - i) Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.
 - ii) Ventilated Panels:
 - a) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel.
 - b) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
 - c) For panels without backs against wall, furnish louvers on top and bottom of panel back.
 - d) Louver Construction: Stamped sheet metal.
 - e) Ventilation Fans:
 - (1) Furnish where required to provide adequate cooling.
 - (2) Create positive internal pressure within panel.
 - (3) Fan Motor Power: 120V ac, 60 Hz, thermostatically controlled.
 - f) Air Filters: Washable aluminum, Hoffman Series A FLT or equal.
 - 3. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
 - i) Provide NEMA 4/4X rated air conditioners. Air Conditioners shall be provided with integral heaters to maintain panel temperature at a minimum of 40 degrees F. Air Conditioners shall be provided to maintain panel temperatures at a maximum of 90 degrees F.
 - ii) Size for 90% duty cycle

-
4. Space Heaters:
 - i) Thermostatically controlled to maintain internal panel temperatures above dew point.
 - ii) Provide in all outdoor enclosures.
 5. Dehumidifier
 - i) Provided when noted.
 - ii) 24VDC powered
 - iii) Din rail mountable
 - iv) Include 4x drain
 - v) Include Hygrostat for controlling the dehumidifier to maintain humidity at or below 65%
 - vi) Manufacturer and Product:
 - a) Pentair; H2Omit Thermoelectric Dehumidifier, or equal
- D. Special Components:
1. Window Kit:
 - i) Provide for all outdoor mounted enclosures having panel mounted Operator Interface Units (OIUs).
 - ii) Stainless Steel lockable front of panel mounted window kit to protect operator interface unit from outdoor conditions.
 - iii) Size to fit operator interface and allow viewing of entire screen without opening window. Provide window kit depth as required to accommodate operator interface unit.
 - iv) Window Kit: NEMA 4X 316 stainless steel.
 - v) Handle: Quarter turn with locking hasp or keylockable.
 - vi) Manufacturer: Pentair A80WS Deep-Hinged window kit, or equal.
 2. Folding Shelf
 - i) Provide for all enclosures containing a Programmable Logic Controller
 - ii) Mounted on interior of enclosure door
 - iii) Materials:
 - a) Outdoor or wet locations
 - (1) Stainless steel.
 - b) Indoor dry locations
 - (1) Heavy Gauge Steel
 - iv) Minimum Thickness: 12 gauge, unless otherwise noted
 - v) Manufacturer: Pentair or equal.
 3. Door Stop Kit
 - i) Provide for all enclosures containing a Folding Shelf
 - ii) Manufacturer: Pentair or equal.
 4. Breather and Drains: Furnish with NEMA 250, Type 3RX, 4, and 4X panels:
 - i) Manufacturer and Product:
 - ii) Hoffman; H2Omit Stainless Steel Vent Drain
 - iii) Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1 N4D, Breather Model ECD1 N4B.
 5. Hygrostat Relative Air Humidity Switch:
 - i) Din rail mountable
 - ii) Max switching capacity 5A minimum

-
- iii) Manufacturer: Schroff or equal
 - E. Freestanding Panel Construction:
 - 1. Materials:
 - i) Outdoor or wet locations
 - a) Type 316 stainless steel.
 - b) Finish: Powder coated white.
 - c) Minimum Thickness: 12 gauge, unless otherwise noted.
 - ii) Indoor dry locations
 - a) Type
 - b) Finish:
 - c) Minimum Thickness: 12 gauge, unless otherwise noted.
 - 2. Panel Front:
 - i) Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
 - ii) No seams or bolt heads visible when viewed from front.
 - iii) Panel Cutouts: Smoothly finished with rounded edges.
 - iv) Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
 - 3. Internal Framework:
 - i) Structural steel for instrument support and panel bracing.
 - ii) Permit panel lifting without racking or distortion.
 - 4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
 - 5. Adjacent Panels: Securely bolted together so front faces are parallel.
 - 6. Door:
 - i) Full height, fully gasketed access door where shown on Drawings.
 - ii) Latch: Three-point, Southco Type 44.
 - iii) Handle: "D" ring, foldable type.
 - iv) Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
 - v) Rear Access: Extend no further than 24 inches beyond panel when opened to 90 degree position.
 - vi) Front and Side Access Doors: As shown on Drawings.
 - 7. Manufacturers:
 - i) Weathershed
 - ii) Hoffman Engineering Co.
 - F. Nonfreestanding Panel Construction:
 - 1. Based on environmental design requirements provide the following:
 - i) For panels listed as inside, air conditioned:
 - a) Enclosure Type: NEMA 12 in accordance with NEMA 250.
 - b) Materials: Steel.
 - ii) For all other panels:
 - a) Enclosure Type: NEMA 4X in accordance with NEMA 250.
 - b) Materials: Type 316 stainless steel.
 - 2. Metal Thickness: 14 gauge, minimum.
 - 3. Doors:
 - i) Rubber-gasketed with continuous hinge.

-
- ii) Stainless steel lockable quick-release clamps.
 - 4. Manufacturers:
 - i) Hoffman Engineering Co.
 - G. Factory Finishing:
 - 1. Enclosures:
 - i) Stainless Steel and Aluminum:
 - a) Indoor: Not painted.
 - b) Outdoor: Paint all inside and outside surfaces white using electrostatically applied TGIC polyester urethane powder coating.
 - ii) Nonmetallic Panels: Not painted.
 - iii) Steel Panels:
 - a) Sand panel and remove mill scale, rust, grease, and oil.
 - b) Fill imperfections and sand smooth.
 - c) Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
 - d) Sand surfaces lightly between coats.
 - e) Dry Film Thickness: 3 mils, minimum.
 - 2. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

1.7.5.3 General Layout

1.7.5.4 NAMEPLATES AND TAGS

- A. Panel Nameplates: Enclosure identification located on enclosure face.
 - 1. Location and Inscription: As shown on Drawings.
 - 2. Materials: Adhesive-backed, phenolic UV rated.
 - 3. Letters: 1/2 inch-high, black on white background, unless otherwise noted.
- B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.
 - 1. Location and Inscription: As shown on panel drawing.
 - 2. Materials: Adhesive-backed, phenolic UV rated.
 - 3. Letters: 3/16 inch-high, black on white background, unless otherwise noted.
- C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.
 - 1. Inscription: Component tag number.
 - 2. Materials: Adhesive-backed, laminated plastic.
 - 3. Letters: 3/16 inch-high, white on black background, unless otherwise noted.
- D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.
 - 1. Inscription:
 - 2. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
 - 3. Refer to table under Paragraph Standard Light Colors and Inscriptions.
 - 4. Refer to P&IDs on Drawings.
 - 5. Materials: Stainless steel or phenolic UV rated, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
 - 6. Letters: Black on white background.
- E. Nametags: Component identification for field devices.
 - 1. Inscription: Component tag number.
 - 2. Materials: 16 gauge, Type 304 stainless steel.
 - 3. Letters: 3/16 inch-high, imposed.
 - 4. Mounting: Affix to component with 18 gauge stainless steel wire or stainless steel screws.

1.7.6 Electrical Requirements

1.7.6.1 Wires

- A. General
 - 1. All field wire to be “quick pull”
 - 2. Terminals installed to provide 2” minimum spacing from Panduit to terminal wire entry.
 - 3. Labels installed 1” from connection point.
- B. AC Circuits:
 - 1. Type: 300-volt, Type MTW stranded copper.
 - 2. Size: For current to be carried, but not less than 18 AWG.
- C. Analog Signal Circuits:
 - 1. Type: 300-volt stranded copper, twisted shielded pairs.
 - 2. Size: 18 AWG, minimum.
 - 3. Each signal protected with micro circuit breaker
 - i) Manufacturers:

24 VDC +	Blue
24 VDC -	White on Blue
4-20 mA +	Red
4-20 mA -	Black
Ground-Signal	Green
Ground-Panel	Yellow on Green

1.7.6.2 Power Distribution within Panels:

A. Feeder Circuits:

1. One or more 120V ac, 60 Hz feeder circuits as shown on Drawings.
2. Make provisions for feeder circuit conduit entry.

B. Circuit Breakers: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.

1. Type: Thermal Magnetic
2. Provide UL listed breakers.
3. Provide Din Rail mountable breakers.
4. Locate to provide clear view of and access to breakers when door is open.
5. Breaker sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
 - i) Branch Circuit Breaker: 15 amps at 250V ac.
6. Breaker Manufacturers and Products:
 - i) Allen-Bradley; 1492 series.
 - ii) Allen-Bradley; 1489-A series.
 - iii) Square D; Multi 9 series.
 - iv) Phoenix Contact CB TM1 .5A SFB P – 2800835 for circuits less than 0.5 amps.

1.7.6.3 Terminal Blocks for Enclosures

A. Quantity:

1. Accommodate present and spare indicated needs.
2. Wire spare PLC and RTU I/O points to terminal blocks.
3. One wire per terminal for field wires entering enclosures.
4. Maximum of two wires per terminal for 18 WG wire for internal enclosure wiring.

-
- 5. Spare Terminals: 20 percent of all connected terminals, but not less than 10 per terminal block
 - B. General:
 - 1. Connection Type: Push-in top entry
 - 2. Mounting:
 - i) Standard DIN rail.
 - ii) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - iii) End Stops: Minimum of one at each end of rail.
 - 3. Single level only.
 - 4. Supports the installation of shunt resistors.
 - 5. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - C. Terminal Block, General-Purpose:
 - 1. Rated Voltage: 600V ac.
 - 2. Rated Current: 30 amp.
 - 3. Wire Size: 18 AWG to 10 AWG stranded without ferrule.
 - 4. Color:
 - i) Grey body typical.
 - ii) Ground: Green and Yellow
 - 5. Spacing: 0.25 inch, maximum.
 - 6. Manufacturer and Product:
 - i) Phoenix Contact CLIPLINE series
 - ii) WAGO TOPJOB series

1.7.6.4 Relays:

- A. Quantity:
 - 1. Accommodate present and spare indicated needs.
 - 2. Wire spare PLC and RTU I/O points to Relay and Relay to terminal blocks.
- B. General:
 - 1. Relay Mounting: Octal Plug-in type socket.
 - 2. Type: Dry circuit.
 - 3. Coil Voltage: 24 VDC unless otherwise noted
 - 4. Contact Arrangement: 2 Form C contacts
 - 5. Indication Type: LED indicator lamp
 - 6. Push to test button
 - 7. Socket Mounting: Din Rail.
 - 8. Manufacturer and Product:
 - i) Allen Bradley 700-HA series
 - ii) Omron MKS2P series

1.7.6.5 Power Supplies:

- A. 24 VDC:
 - 1. Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.
 - 2. Convert 120V ac, 60 Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
 - 3. Provide output over voltage and over current protective devices to:

- i) Protect instruments from damage due to power supply failure.
 - ii) Protect power supply from damage due to external failure.
- 4. Mount such that dissipated heat does not adversely affect other components.
- 5. Manufacturer and Product: SOLA: SDN-P

1.7.6.6 Internal Panel Lights

- A. Type: Switched LED lights.
- B. Quantity: One light for every 4 feet of panel width.
- C. Mounting: Inside and at the top
- D. Manufacturer and Product: Lumapro Cabinet light LED, 33L570

1.7.6.7 Service Outlets for Freestanding Panels

- A. Type: Breaker protected, Three-wire, 120 volt, 15 ampere, GFCI duplex receptacles.
- B. Manufacturer and Product: Cooper/Eaton, NEMA 5-20-5362CR, Industrial Grade Corrosion Resistant

1.7.6.8 Standard Pushbutton Colors and Inscriptions:

- A. Use following color code and inscriptions for pushbuttons, unless otherwise noted

Inscription(s)	Button Color
ON OFF	Black Black
OPEN CLOSE	Black Black
OPEN CLOSE AUTO	Black Black Black
ON OFF AUTO	Black Black Black
MANUAL AUTO	Black Black
START STOP	Black Black
RESET	Black
EMERGENCY STOP	Red

- B. Lettering Color: Black Lettering on white background

1.7.6.9 Standard Light Colors and Inscriptions:

- A. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted. In all cases the LED bulb shall be clear.

Inscription(s)	Lens Color
ON	Red
OFF	Green
OPEN	Red
CLOSED	Green
LOW	Amber
FAIL	Amber
HIGH	Amber
AUTO	Clear
MANUAL	Clear
LOCAL	Clear
REMOTE	Clear
AC POWER	White

B. Lettering Color: Black Lettering on white background

1.7.6.1 Standard Pushbuttons and LEDs

A. Manufacturer and Product: Allen Bradley 800G series

B. LEDs to be installed in LED base, LED bulbs in incandescent bases shall not be used.

1.7.6.2 ELECTRICAL TRANSIENT PROTECTION

A. General:

1. Function: Protect elements of control panels against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
2. Implementation: Provide, install, coordinate, and inspect grounding of surge suppressors at:
 - i) Connection of ac power to panels, consoles assemblies, and field mounted analog transmitters and receivers.
 - ii) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
3. Recovery: Automatic.

B. Suppressor Locations:

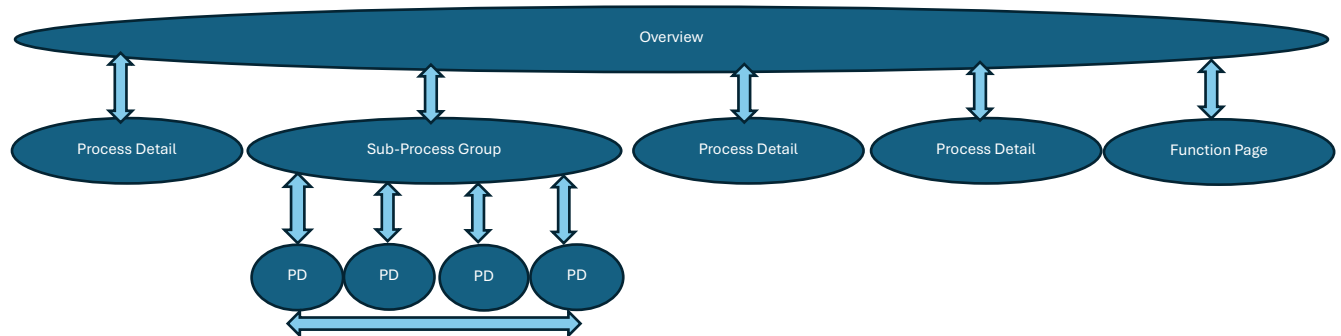
1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
2. Analog Wires: At each end when the pair travels outside of building.

-
3. Discrete Wires: At control panel end when the wire travels outside of building.
 4. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment
 5. In other locations where wires travel outside of building.
- C. Manufacturer and Product:
1. Incoming 120 VAC power: Ditek, DTK-120/240CM
 2. Analog Signals
 - i) Din Rail Mountable
 - ii) Emerson SS64038-3 or Equal

Graphics Design Guidance for IFIX Applications

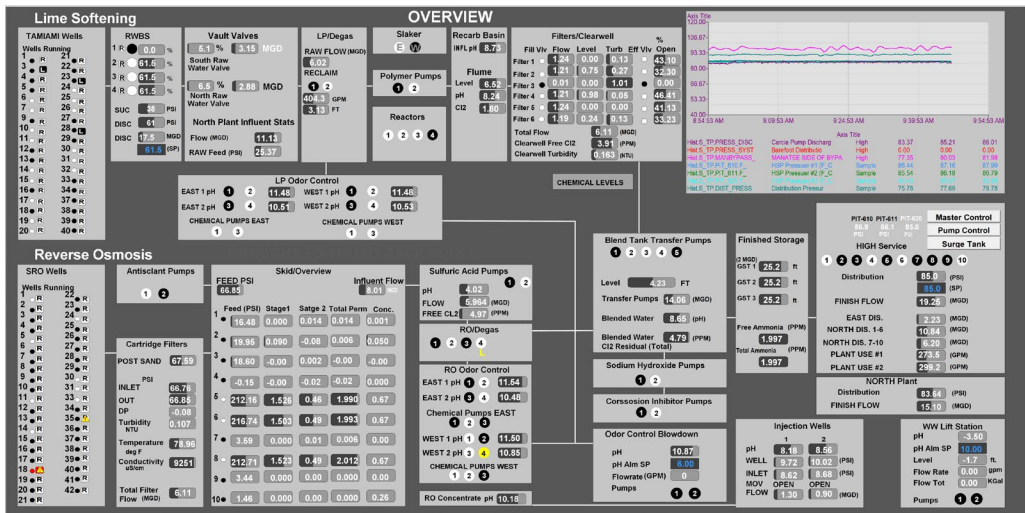
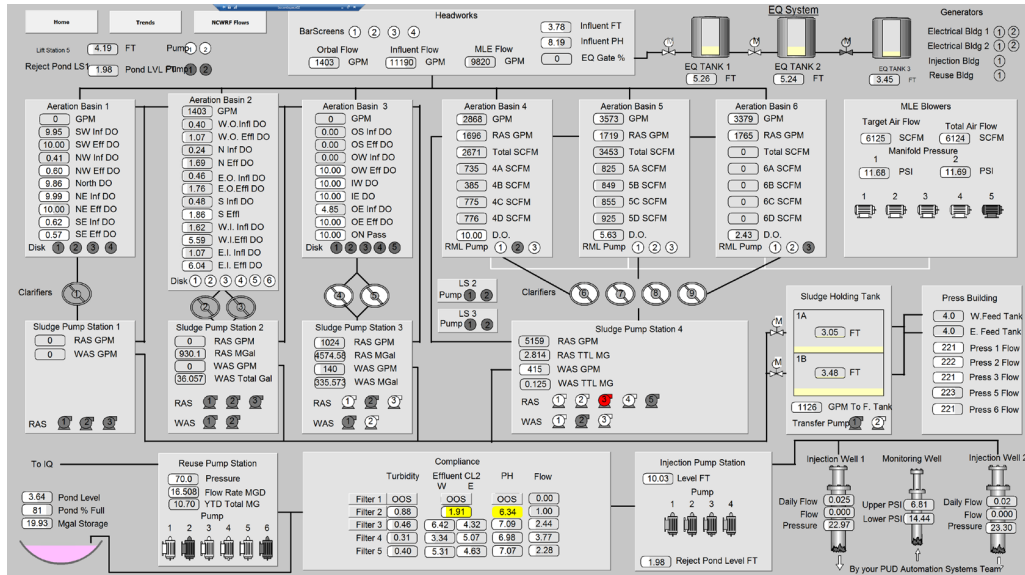
Navigation/Organization:

- The main screen should be an Overview of the plant with little to no control functions, highlighting key parameters from each process that would be leading indicators of quality of function.
- The Overview Screen should reference all Processes at the site/system as well as special Functions.
- Each Process should have a Process Detail (PD) screen where the added details and control functions should reside.
- Similar replicated processes such as RO Skids, Wells, etc. can be grouped into Sub-Process Group (SPG) screens, where controls and added indication would exist.
- SPG screens can navigate down further into specific PD screens for each individual process.
- Function Pages would be for things not related to specific process such as trending, alarming, totalizers, summaries, and other analytics.
- All navigation shall be down from overview and back up to overview. If an SPG is used it can be included in the path.
- No lateral navigation shall exist between processes except for PD screens below a SPG screen



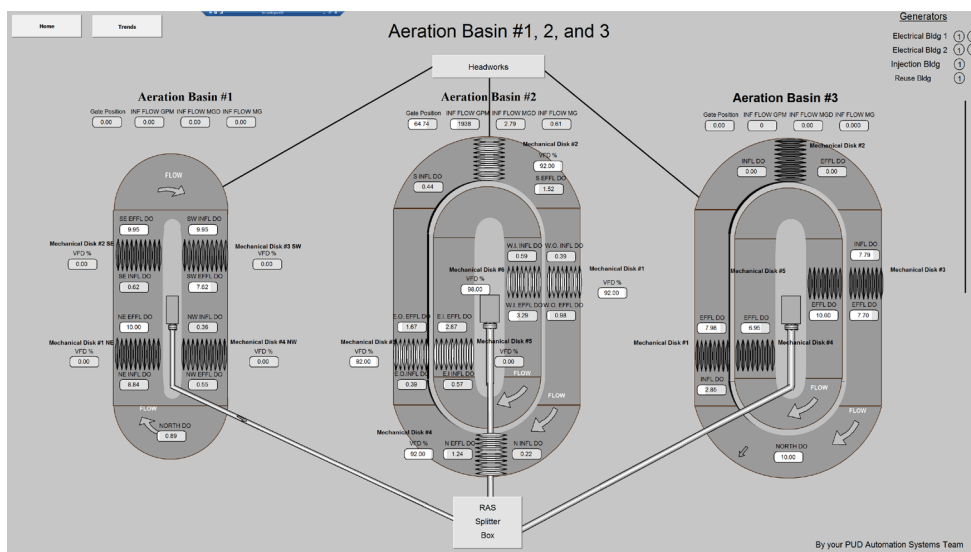
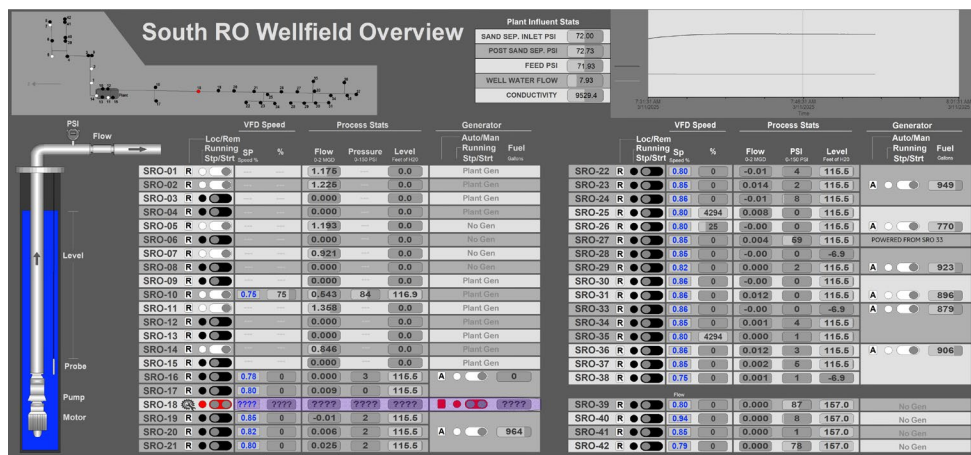
Overview Layout:

- Each Process should have a segmented area grouping its related data together, and each area should have a line representing connected processes.
- Navigation should be embedded. When you click on a process, it should drill into the related PD or SPG screen.
- Title is optional.

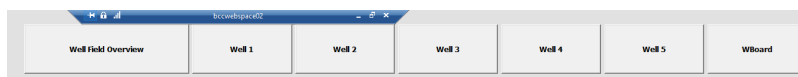


Sub-Process Group Layout:

- This screen is more flexible depending on the relationship and quantity of related processes.
- This can be a summary table of values, maps/diagrams of process system, etc.
- If there are common interlocks, or indications, they should be represented here outside of individual process areas.
- Control is allowed here if it makes sense. Detailed configurations should still likely be on a more drilled in screen per process.

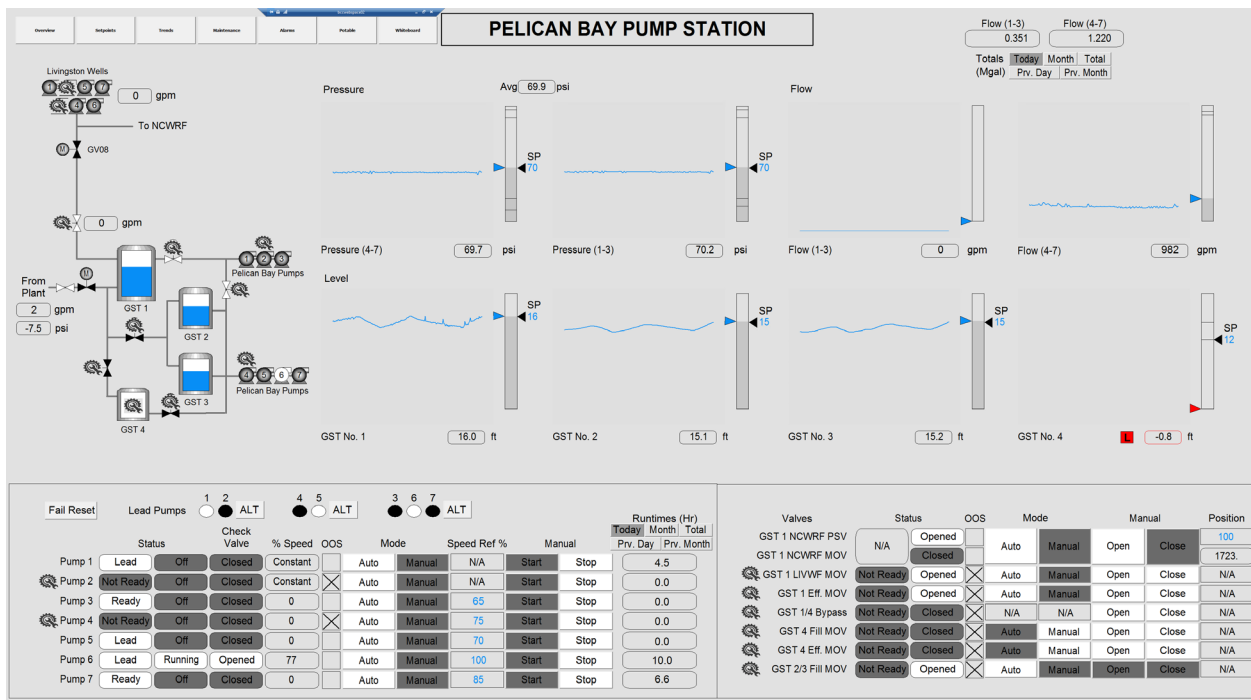


Below you can see an example of limited lateral navigation... you can jump to other wells, but not out of the wellfield all together except back to the sub process overview page.



Process Detail Layout:

- Process Detail screens should have 4 major areas of focus
 - Navigation and configuration popup buttons across the top, with a title in the center.
 - Process diagram left of center – middle vertical.
 - Thumbnail Trends right of center – middle vertical.
 - Process controls – bottom.
- Configuration would include:
 - Background setpoints
 - Maintenance offsets
 - Site allotments/operating targets
 - Alarm configurations
- The process diagram should have as much relevant process status details as reasonable.
 - Pump/Valve conditions.
 - Flow/PSI/Level indications.
- The thumbnails can be as detailed as is helpful in operating the process
- The process controls should have separate buttons for every function, no toggles!



Status Bar:

- At all times throughout the application a status bar should be present at the base of the screen highlighting the following information:
 - Current Logged in user
 - Server status (S1/S2)
 - Some sort of indication as to whether or not a server is connected and healthy
 - Connected source
 - Which server is actively feeding data to the client
 - Failover Button
 - Force a swap of server sources
 - Alarm Counter
 - How many active and unacknowledged alarms are live in the system
 - Historian Source Health indication.
 - Some sort of validation that the historian is collecting and feeding data to the clients.
 - Date/Time
 - Local PC date/time
- This bar should be as small as reasonable. ~3-5% of the total screen space.



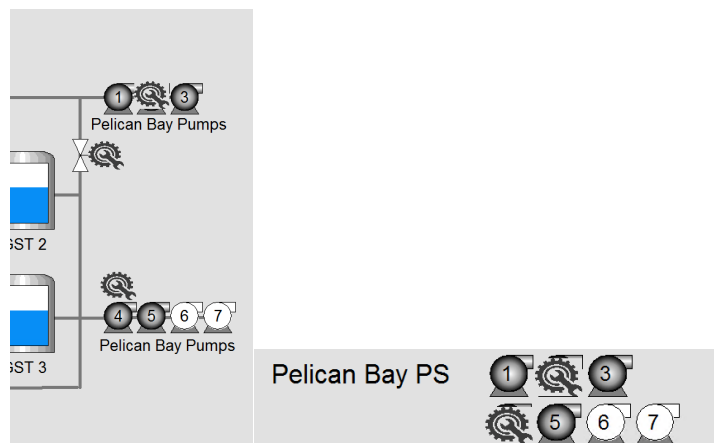
Color Standards:

- Black (0,0,0)(0)
 - Digital indication: off/closed/disabled.
 - Analog indication: Foreground Fill
- Less than 50 Shades of Grey
 - Digital indication: Transition between states, opening/closing, starting/stopping
 - Analog indication: Background Fill
 - Picture background and block foreground colors.
- White(255,255,255)
 - Digital Indication: on/open/engaged.
 - Analog indication: Animated Text
- “Raabe” Blue(HEX 16158215)(Standard Palette : Color 199)(RGB:213,0,50)
 - Setpoints, operator data entry.
 - Secondary trending colors
- Red
 - Faults – equipment shutdowns.
- Yellow
 - Alarms – approaching shutdown conditions, but not yet there.
- Purple
 - Comm loss
- Green
 - Trending and Analog fills

Out of service:

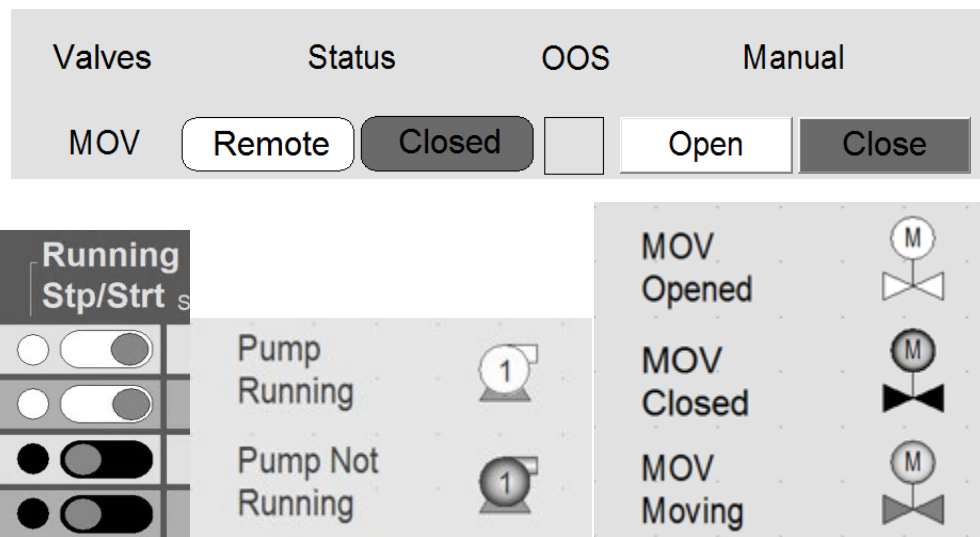
- Out of service is a maintenance mode that suspends related process alarms, marks indications as not to be trusted, as well as inhibits control of the related equipment.
- This should be functionally managed at the process PLC
- An indication on the process/equipment should be present when active showing the maintenance icon over the equipment/process in question
- Related controls/indications should have a cross hatched block placed on top indicating they are affected by the OOS
- OOS can be applied at different levels:
 - Process/Assembly – Disabling a skid, well, or pump station can happen with a single OOS
 - Application at this level would also place all sub-components in OOS
 - Sub-Process – Everything related to a single sub process where parallel sub processes exist.
 - I.e. one pump, and related indications/alarms out of a multi pump system.
 - Equipment – A singular instrument, pump, or valve could happen without disabling the larger assembly.
 - Application at this level would remove the device from interlocks and alarms, while allowing the larger structure to remain in function.

	Status	Check Valve	% Speed	OOS	Mode	Speed Ref %	Manual	Start	Stop	Today	Month	Total
										Prv. Day	Prv. Month	
Pump 1	Lead	Off	Closed	Constant	☐	Auto	Manual	N/A	Start	Stop		6.2
 Pump 2	Not Ready	Off	Closed	Constant	☒	Auto	Manual	N/A	Start	Stop		0.0
Pump 3	Ready	Off	Closed	0	☐	Auto	Manual	65	Start	Stop		5.7

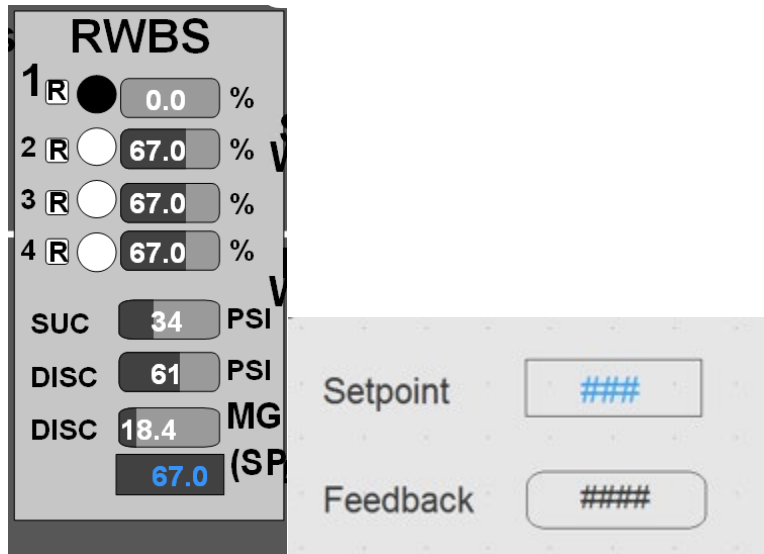


Standard Objects:

- Digital Controls
 - Large
 - Square Cornered Rectangle
 - Separate text object on top for label. Do not use embedded text
 - Small
 - Slider button. (Rounded rectangle with two circles)
 - Labels above
- Digital Feedback
 - Large
 - Same as control but with Rounded Rectangle
 - Small
 - Radio Button adjacent to slider.
 - Can also use small simple valve or pump indications where it helps distinguish function.



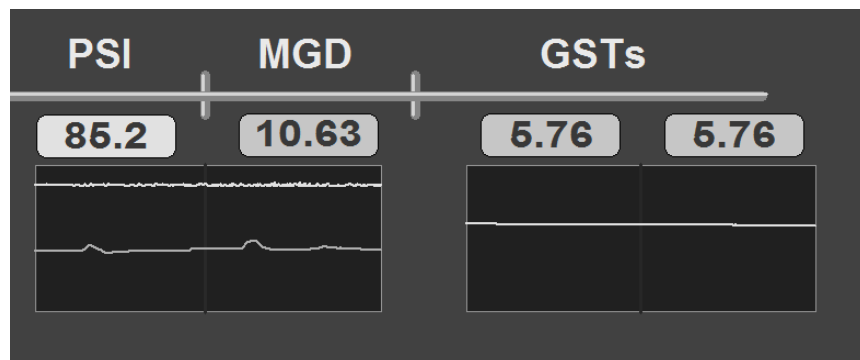
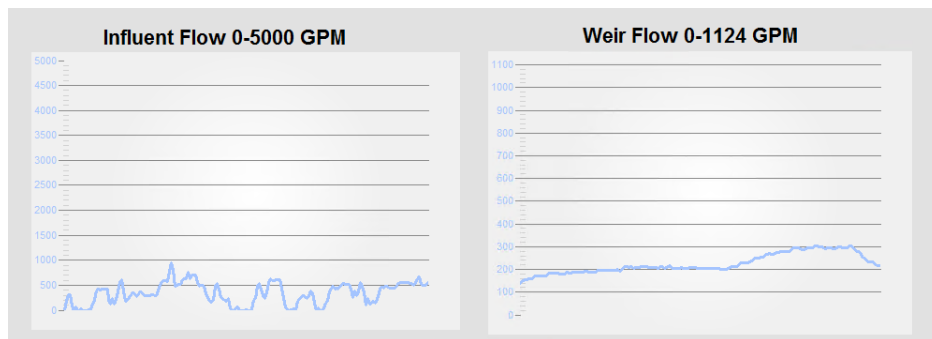
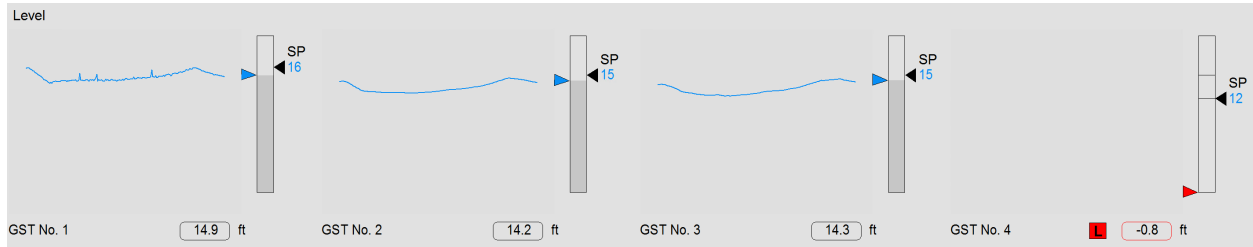
- Analog Controls
 - Same framing rules, Squared Rectangle, with datalink overlay.
 - Operator data entry text should be colored blue to indicate control vs feedback.
- Analog Display
 - Rounded Rectangle, with datalink overlay
 - Backfill optional if it helps with context.
 - Text should be black/grey/white depending on background. Max contrast.



Pressure	72.26	PSI	Flow Rate SP	300	GPM	High Level Alarm	11.00	ft
Current Flow	0	GPM	Max. Flow	50.000	kGal	MOV Shutoff	10.00	ft
	0.000	MGD	Today's Flow	0.000	kGal	Level	9.83	ft

- Thumbnail Trends

- Small historical trend
- Normally a single pen only, 2 at most.
- Minimal gridlines/axis labels.
- Can include scales/alarms/setpoints as needed.



- Alarm Indication
 - High- and Low-level alarms/faults.
 - Squares with H or L and appropriate color
 - Yellow – Alarm
 - Red - Fault
 - General Alarms/Faults
 - Yellow Triangle with Red Border and exclamation point

High High Level Alarm	
High Level Alarm	
Low Level Alarm	
Low Low Level Alarm	
Equipment Alarm	