

SECTION 01 00 00

GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 QUALIFICATION

- A. The Bidder shall be able to demonstrate that it possesses the necessary proficiency and experience, the Bidder's Firm shall have been regularly engaged in the construction of projects involving the installation of process equipment at municipal water/wastewater treatment facilities in Florida for at least the last five consecutive years and shall have completed at least five projects of similar size, value, and complexity within the last five years. The Bidder shall be a Florida state certified General Contractor. The Bidder shall perform at least 50% of the contract work with his/her own forces.

1.02 EXISTING UTILITIES AND STRUCTURES

- A. The existing utilities and facilities shall be located from the Owner's and other records. Guaranty is not made that all existing facilities are shown/located or that those shown/located are entirely accurate. The Contractor shall assure themselves of any utilities, structures or facilities prior to performing any Work. Prior to the start of Work, the Contractor shall request the Owner to advise him of the location of their facilities in the vicinity. The Owner and the Engineer will assume no liability for damages sustained or costs incurred because of the Contractor's operations in the vicinity of existing utilities or structures. The Contractor shall notify the Engineer of any deviation between existing conditions and the information provided by the Engineer or Owner.

1.03 PRESERVING WATER QUALITY

- A. The Contractor shall exercise extreme care to minimize degradation of water quality at the site. All necessary provisions shall be taken to insure compliance with the water quality standards of the State of Florida.
- B. The Contractor shall take steps to collect and dispose of all sewage that leaks and/or spills during the performance of this contract. Any leakage or spillage shall be cleaned up to the satisfaction of the Nassau County Health Department.

1.04 PROTECTION OF EXISTING AND ADJACENT PROPERTIES

- A. Unless indicated otherwise, all shrubbery, paved streets and walks, fences and walls, adjacent structures and equipment shall be fully protected against damage

during each stage of the project. Any damage by the Contractor shall be fully restored to its condition at the start of construction.

1.05 RESTORATION OF DAMAGED SURFACES, STRUCTURES, AND PROPERTY

- A. Where pavement, trees, shrubbery, fences or other property or surface structures not designated as pay items, have been damaged, removed or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the Contract Documents, state laws, municipal ordinances or the specific direction of the Engineer, or through failure to employ usual and reasonable safeguards, such property and surface structures will be replaced or repaired at the expense of the Contractor to a condition equal to that before Work began within a time frame approved by the Engineer.

1.06 SUBSTITUTIONS (NOT USED)

1.07 WATER

- A. The Contractor shall provide water for their use for construction purposes. The Contractor shall be responsible for the installation of an Owner water meter at a location approved by the Engineer. The Contractor shall install and maintain necessary supply connections and piping for same.

1.08 SANITARY FACILITIES

- A. The Contractor shall provide temporary restroom facilities for field crews as permitted by the Nassau County Health Department. Existing Owner facilities are not available for use by the Contractor.

1.09 WORKING HOURS

- A. Work under this contract shall not be performed on County, State and/or national holidays or during such events as the Fernandina Beach Shrimp Festival, Nassau County School System FCAT (as identified at the pre-bid conference), except in time of emergency, and then only under written permission from the County who shall be the sole judge as to the urgency of that situation. Available workdays to perform work will not include night time work, weekend work, or work before 8:00 am or after 5:00 pm (40 hours per work week).

Should the Contractor deem it necessary to work on Sundays, holidays, or beyond daylight hours in order to comply with his construction schedule or because of an emergency, the Contractor shall request permission of the County. If, in the opinion of the County, the need is bona fide, the County will authorize the Contractor to work such hours as may be necessary.

- B. Should the County approve work time beyond regular hours, the following hourly rates shall be applied as the County's reimbursement of Engineer of Record's fee to be paid by Contractor for expenses defined in Supplemental Conditions SC-6.02.C, SC-6.05.A.2.f, SC-6.17.E., SC-9.05.B and SC-13.03.A.

1. Engineer	\$202.69
2. Project Engineer	\$115.49
3. Construction Administrator	\$134.92
4. Inspector	\$96.07
5. Administrative Assistant	\$53.21
6. Consultant Construction Engineering Inspection (CEI)	\$69.35

1.10 ASSEMBLIES OR UNITS

- A. Where the Contractor is required to furnish and install an assembly or unit, the Contractor shall furnish all component parts as required by the manufacturer of the unit.

1.11 ACCESS TO THE WORK SITE

- A. The Contractor may use only the roads and/or easements designated by the Owner for access to the work locations. The Contractor shall be responsible for maintaining, protecting and restoring the routes to the satisfaction of the Owner and Engineer.

1.12 BARRICADES AND LIGHTS

- A. The Contractor shall furnish and erect such barricades, fences, lights, and danger signals and shall provide such other precautionary measures for the protection of persons or property and of the work as necessary. Barricades shall be painted in a color that will be visible at night. From sunset to sunrise, the Contractor shall furnish and maintain at least one light at each barricade and sufficient numbers of barricades shall be erected to keep vehicles from being driven on or into any work under construction.
- B. The Contractor will be held responsible for all damage to the work due to failure of barricades, signs, and lights to protect it and whenever evidence is found of such damage, the Contractor shall immediately remove the damaged portion and replace it at his cost and expense. The Contractor's responsibility for the maintenance of barricades, signs, and lights shall not cease until the project has been accepted by the Owner.

1.13 SECURITY

- A. The Contractor shall be fully responsible for the safety and security of the work area. Any temporary measures required to maintain the security of the area shall be the Contractor's responsibility.

1.14 TRENCH SAFETY ACT

- A. All work shall conform to the Trench Safety Act. Contractor shall include in his price the cost of conforming to the Trench Safety Act.

1.15 PROJECT SCHEDULE

- A. The Contractor shall develop and submit to the Engineer and Owner for approval an initial progress schedule and a construction phasing plan demonstrating complete fulfillment of all contract requirements including all activities of subcontractors, equipment vendors and suppliers. An updated schedule shall be submitted with each pay request.

1.16 TEST OR OPERATION

- A. Upon completion of work, it shall be the Contractor's responsibility to turn the installation over to the Owner in good operating condition. This shall be demonstrated by a test run of the system by the Contractor in the presence of the Owner and/or Engineer.

1.17 REMOVAL OF ALL TEMPORARY FACILITIES & RESTORATION OF SITE

- A. Upon completion of the work, it shall be the responsibility of the Contractor to remove all temporary facilities including but not limited to pumps, fences, signs, temporary power, materials or other debris. The site, adjacent properties and Owner facilities, shall be restored to condition equal to that before Work began.

1.18 RECORD DOCUMENTS

- A. The Contractor shall maintain on site one set of the following record documents for use to record actual revision to the Work:
 - 1. Exhibits
 - 2. Specifications
 - 3. Addenda
 - 4. Change Orders and other modifications to the Contract
 - 5. Approved Shop Drawings, product data, and samples

- B. The Contractor shall provide As Built Redline Drawings for partial releases and final release submittals. With each submittal provide survey data, signed and sealed by the Contractor's Florida Licensed Surveyor, to support elevation information depicted on the record drawings.

The final record drawings shall correctly and accurately show all the new installation reflecting surveyed information performed, signed and sealed by a professional land surveyor and mapper registered in the State of Florida. The drawings shall be neat and legible. All elevations shall be based on State Plane Coordinates NAVD-88 Datum. Record drawings shall comply with Nassau County Engineering Services As-Builts Requirement Checklist.

- C. Upon completion of the project, final record drawings will be provided to the Owner on CD-Rom, Autocad DWG format, along with one set of PDF (24"x36") along with a complete set of all survey data, signed and sealed by a professional Land Surveyor and Mapper in the State of Florida.
- D. Engineer-of-Record\Owner reserves the right to review Contractor's As-Built drawings during course of construction.
- E. Final pay and connections to any existing utility main will not be approved until Record Drawings are approved and accepted by Engineer-of-Record\Owner.

1.19 PROVISION FOR THE CONTROL OF DUST

- A. The Contractor shall take the necessary steps to prevent objectionable blowing or drifting of dust, sand, and other debris where the construction occurs in residential, commercial, or other developed areas.
- B. Extreme precautions shall be taken during construction to minimize the amount of dust created. Wetting the site or other means as directed by the Owner, may be required for control of dirt.

1.20 OBSTRUCTION

- A. The attention of the Contractor is drawn to the fact that during construction at the project site, the Contractor will encounter electrical lines. The Contractor shall exercise extreme care before and during construction to locate and flag these lines so as to avoid damage to the existing lines. Should damage occur to an existing line, the Contractor shall repair the line at no cost to the Owner.
- B. It is the responsibility of the Contractor to ensure that all utility or other poles, the stability of which may be endangered by the close proximity of construction, are temporarily stayed in position while the work proceeds in the vicinity of the pole and that the utility or other companies concerned be given reasonable advance notice of any such construction activities by the Contractor.

1.21 CLEAN-UP

- A. The Contractor shall maintain the site of the work in a neat condition. The Contractor shall remove all excess materials, excess excavated materials and all debris resulting from his operations within a time frame approved by the Engineer.

1.22 DESIGN PROFESSIONALS REPRESENTING OWNER

- A. Various Design Professionals (i.e. Civil, Mechanical, Electrical, etc.) as consultants to the Owner prepared the specifications for the project. The Owner may have the various Design Professionals provide services to the Owner during construction phase of the project. The Design Professionals will be representatives of the Owner and visits to the site by the Design Professionals will be on the basis of paragraph 1.22 of this section. Also paragraph 1.23 of this section includes the various Design Professionals for this project.

1.23 VISITS TO SITE BY OWNER'S REPRESENTATIVE

- A. The Owner's representative will make visits to the site at intervals appropriate to the various stages of construction to observe the progress and quality of the executed work and to determine, in general, if the work is proceeding in accordance with the Contract Documents.
- B. The Owner's representative's efforts will be directed toward providing for the Owner a greater degree of confidence that the completed work will conform to these specifications. On the basis of such visits and on-site observations, the Owner's representative will keep the Owner informed of the progress of the work and will endeavor to guard the Owner against defects and deficiencies in the work.

1.24 LIMITATIONS ON OWNER'S REPRESENTATIVE RESPONSIBILITIES

- A. Neither the Owner's representative's authority to act under these specifications or elsewhere in other documents nor any decision made by the Owner's representative in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of the Owner's representative to the Contractor, any sub-Contractor, any manufacturer, fabricator, supplier or distributor, or any of their agents or employees or any other person performing any of the work.
- B. The Owner's representative shall not be responsible to the Contractor's means, methods, techniques, sequences or procedures of construction, or safety precautions and programs incident thereto, and the Owner's representative shall not be responsible for the Contractor's failure to perform the work in accordance with these specifications.

- C. The Owner's representative shall not be responsible for the acts or omissions of the Contractor or of any sub-Contractors, or of any other persons at the site or otherwise performing any of the work.

1.25 WARRANTY

- A. The Contractor shall be responsible for defects in materials (including latent defects) or workmanship for a period of two years after the date of final acceptance of the project by the Owner. Such defects include, but not limited to, any settlement noted in backfill, fill, or in structures built over the backfill or fill during the warranty period in accordance with the General Conditions will be considered to be caused by improper compaction methods and shall be corrected by the Contractor at no cost to the Owner. Structures damaged by settlement shall be restored to their original condition by the Contractor at no cost to the Owner.
- B. The Contractor shall furnish factory warranty on all equipment furnished for the performance and completion of the project against defects in materials and/or workmanship. The factory warranty shall become effective for a period of two years after the date of final acceptance of the project by the Owner. Should any defects in materials or workmanship be brought to the attention of the Contractor within the factory warranty period, the Contractor shall replace at no cost to the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 11 00

SUMMARY OF WORK

PART 1 – GENERAL

1.01 LOCATION OF WORK: The project site is at the following locations in Nassau County, Florida:

A. The entrance of the Omni Amelia Island Resort at 39 Beach Lagoon Rd, Fernandina Beach, Florida

1.02 DESCRIPTION OF WORK:

This project consists of replacement of Amelia Island Pump Station for Nassau Amelia Utilities. The work to be performed is generally described as demolition of the existing Amelia Island Booster Pump Station including high service pumps, generator, 0.4 MG ground storage tank, one 0.1 MG hydropneumatic tank, one diesel storage tank, and related piping. Installation of seven horizontal split case centrifugal pumps, precast concrete booster pump building, precast concrete restroom building. Construction of 1 million-gallon ground storage tank. Installation of a new precast concrete electrical control building and a new generator with integral fuel storage tank. Installation of a new security fence around the entrance and no rill, site perimeter including a new main gate. Installation of associated yard piping, valves and appurtenances, associated electrical, instrumentation, and controls.

Site furnishing of all equipment, labor, materials and supervision necessary for replacement of Amelia Island pump station, including but not limited to all demolition, proper disposal, pump, pipe and valve replacement, electrical and mechanical demolition and replacement, associated site grading and restoration, pump and haul operations, all associated materials, labor and equipment, and all incidental work as called for in the Contract Documents complete and in place. The Contractor shall furnish, install, test and place in operation the booster pump station shown on the drawings and specified hereinafter. All applicable sections of Nassau County Standard Specifications and JEA 2019 Water and Wastewater Standards shall be considered part of this work. All references to Industry Standards (ASTM, ANSI, etc.) shall be to the latest revision unless otherwise stated. Only those materials included in the JEA Water and Wastewater Standards Manual, unless called out different within the Contract Documents, shall be installed. All materials shall be new unless specifically called for otherwise. All structures, pumps and panels shall require a complete shop drawing submittal, as detailed in this specification for review and approval prior to the start of construction.

All work shall be in accordance with the construction specifications, and contract documents.

1.03 CONTRACTOR'S DUTIES: Except as specifically noted, the Contractor shall provide and pay for the following:

- A. All labor, materials and equipment.
- B. Tools, construction equipment and machinery.
- C. Utilities required for construction.
- D. Other services and facilities necessary for the proper execution of work completion including incidental items not detailed or called for, but which are required for the proper completion of the project.
- E. All legally required sales, consumer and use taxes.
- F. All applicable permits, government fees and licenses.
- G. Survey services for construction layout including equipment, piping, fitting, valve laying schedule and record drawings shall comply with Nassau County Engineering Services As-Builts Requirement Checklist.
- H. All required testing and clearances for placing in service.
- I. Restore all sites and structures that are damaged by the Contractor during the execution of this contract at no additional cost to the Owner.

1.04 CONTRACTOR SHALL ALSO BE REQUIRED TO PERFORM THE FOLLOWING:

- A. Comply with all codes, ordinances, rules, regulations, orders and other legal requirements of public authorities which bear on the performance of work.
- B. Prepare all the information for Nassau County Demolition Permit including any testing required for asbestos and lead.
- C. Promptly submit written notice to the Engineer of observed variances of Contract Documents from legal requirements; it is not the Contractor's responsibility to make certain drawings and specifications comply with codes and regulations.

- D. Enforce strict discipline and good order among employees. Do not employ unfit persons or those not skilled in assigned tasks.

1.05 WORK SEQUENCE:

- A. Coordinate with Owner.
- B. Contractors construction schedule will be subject to approval by the Engineer and updated on a monthly basis.
- C. Notify Engineer and Owner 96 hours (minimum) in advance of removing any facility from service, permanently or temporarily. Removal from service of any facility shall be preapproved by Owner.

1.06 CONTRACTORS USE OF PREMISES:

- A. Do not unreasonably encumber sites with materials or equipment.
- B. Assume full responsibility for protection and safekeeping of products stored on premises.
- C. Move any stored products interfering with operation of Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 12 16

SEQUENCE OF CONSTRUCTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. In performing the work shown and specified, the Contractor shall plan and schedule his work in accordance with Section 01 31 13 - Construction Schedule. The work is being performed on active utility facilities which must be maintained in operation throughout construction.

1.02 CONSTRUCTION SCHEDULE

- A. The Construction Schedule shall be submitted by the Contractor in accordance with Section 01 31 13 - Construction Schedule and Section 02 41 13 – Demolition.

1.03 SEQUENCE OF CONSTRUCTION

The sequence of construction will be performed with the intent of keeping the existing booster pump station in service throughout the construction sequences. Below are some of the critical items in the sequence by the contractor:

- A. The contractor must locate the mains servicing the existing ground storage tank. These mains should be cut and capped close to the existing pump building so as not to impact the demolition of the ground storage tank or the construction of the new tank.
- B. Demolish the existing ground storage tank, remove foundations and pipe and prepare subgrade for new tank.
- C. Demolish the existing Diesel fuel tank and locate a temporary fuel tank on the southeast side of the existing pump building. Contractor will be responsible for the permitting and cleanup of the diesel fuel system.
- D. Clean site area and prepare for the construction of the new ground storage tank. Construction of the storage tank and piping.
- E. After the tank is complete, preparation of the prefabricated building foundations and underground piping in the area between the tank new pump building and the connection at the interconnect point on the east end of the property.
- F. Work on the new electrical building can start at any time as the proposed area is clear and out of the way of other construction.

- G. Perform the installation of the new pumps and pump building and bathroom building. Energize new building, disinfect and test new facility as well as the new ground storage facility.
- H. After testing open the connections to the existing system and put in service. Test for two weeks.
- I. After approval of the system testing take the existing pump station off-line and demolish building slab and piping under the pump station. Yard piping can be abandoned in place. Meter pits should be broken off two feet below grade and filled in. Hydro-pneumatic tank and slab should also be demolished. The remote pump at the east end should also be taken off line with the existing pump station.
- J. During demolition of the existing pump station a temporary generator will be required to feed the new pump station during power outages.
- K. After demolition of the pump station the new generator and tank can be installed and put into service.
- L. Site clean-up and fencing to complete the project can be finalized.

1.04 CONSTRUCTION PLAN

- A. A plan of construction and operation shall be submitted by the Contractor ten (10) days prior to conducting the Work, showing the proposed sequence, equipment, etc. for review.

1.05 USE OF FACILITIES BEFORE COMPLETION

- A. The Owner reserves the right to enter and use any portion of the constructed facilities before substantial completion of the whole work to be done under this Contract.

1.06 CONNECTION OF EXISTING SYSTEMS

- A. All connections to existing systems shall be performed in such a manner that no damage and minimal interruption is caused to the existing installation. On completion of his installation, the Contractor shall remove the plug or blind flange. All areas of work shall be completed and brought on line without disturbing ongoing operations of the facility. Any damage caused to existing installations shall be repaired or replaced by the Contractor at no additional cost to the Owner.

1.07 COORDINATION WITH PERSONNEL

- A. Before commencing work involving removing or placing in operation existing or new facilities, the Contractor shall notify the Owner at least twenty (20) days in advance in writing. The Contractor is hereby notified that the Water and Wastewater Plants are active plants and that their operation shall not be interrupted at any time, for any reason, during the contract period.
- B. Only the Owner's appointed representative can authorize the shutdown of portions of the facilities. The Contractor shall, under no circumstances, interfere with any facility component without the Owner's authorization, in writing, and without supervision by the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 COORDINATION WITH EXISTING UTILITIES AND OTHER AGENCIES

- A. In the event that the Work involves existing utilities owed by the Owner or other agencies, the Contractor shall notify all utilities in writing with a copy to the Owner and the Engineer before construction is started and shall coordinate his activities with them. The Contractor shall cooperate with the owners of utility lines that may require temporary interruption of service in order to minimize the interruption. The Contractor shall call SUNSHINE a minimum of 72 hours prior to any excavation for location of existing underground facilities.

3.02 COOPERATION

- A. The Contractor shall allow the Owner or his agents, and other project contractors or their agents, to enter facilities being constructed under this Contract for the purpose of constructing, installing, operating, maintaining, removing, repairing, altering or replacing such equipment, pipes, sewers, conduits, manholes, wires, or other structures and appliances which may be required to be installed at or in the Work. The Contractor shall cooperate with all the aforesaid parties and shall allow reasonable provisions for the prosecution of any other work by the Owner, or others, to be done in connection with his work, or in connection with normal use of the facilities.

END OF SECTION

SECTION 01 29 73

SCHEDULE OF VALUES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Submit to the Engineer a Schedule of Values allocated to the various lump sum portions of the Work, at the Pre-Construction Conference, and as otherwise specified or requested to be submitted earlier as evidence of the Apparent Low Bidder's qualifications.
2. Upon request of the Engineer support the values with data which will substantiate their correctness. The data shall include, but not be limited to quantity of materials, all sub-elements of the activity, and their units of measure.
3. The Schedule of Values shall establish the actual value for each activity of the Work to be completed taken from the Construction Schedule, and shall be used as the basis for the Contractor's Applications for Payment.

B. Related Requirements Described Elsewhere:

1. Section 01 29 76 Application for Payment

1.02 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 computer printouts may be considered for approval by the Engineer upon Contractor's request. Identify schedule with:

1. Title of project and location.
2. Owner and purchase order number.
3. Engineer and project number.
4. Name and address of Contractor.
5. Contract designation.
6. 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 item prices for progress payments during construction.
- C. Identify each line item with the number and the title of the respective section of the Specifications.
- D. For each major item of the Work, list sub-values of major products or operations under the major item.
- E. For the various portions of the Work:
 - 1. The amount for each item shall reflect a total installed cost including 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. Paid invoices are required for materials. Payment for materials shall be limited to the invoiced amount only.
 - b. The total installed value.
- F. Round off figures to nearest dollar amount.
- G. The sum of the costs of all items listed in the schedule shall equal the total Contract Price.
- H. For each item which has an installed value of more than \$15,000, provide a breakdown of costs to list major products or operations under each item.

1.03 SUBSCHEDULE OF UNIT MATERIAL VALUES

- A. Submit a separate schedule of unit prices for materials to be stored on site and for those materials incorporated into the Work for which progress payments will be requested.
- B. 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. Copies of paid invoices for component material shall be included with the payment request in which the material first appears.

- C. Only materials unique to the project may be billed when stored on site. Materials of standard use such as conduit, wire, small-diameter pipe, steel, etc., shall not be accepted for payment.
- D. The installed unit value multiplied by the quantity listed shall equal the percentage of the cost of that item in the Schedule of Values.

1.04 REVIEW AND RESUBMITTAL

- A. After review by Engineer, revise and resubmit Schedule of Values and Schedule of Unit Material Values as required.
- B. Resubmit revised schedules in same manner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 76
APPLICATIONS FOR PAYMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Administrative and procedural requirements governing the Contractor's Applications for Payment.

1.02 SCHEDULE OF VALUES:

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
 - a. Contractor's Construction Schedule.
 - b. Application for Payment forms, including Continuation Sheets.
 - c. List of subcontractors.
 - d. Schedule of allowances.
 - e. Schedule of alternates.
 - f. List of products.
 - g. List of principal suppliers and fabricators.
 - h. Schedule of submittals.
 - 2. Submit the Schedule of Values to the Engineer at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.
 - 3. Subschedules: Where Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.

- B. Format and Content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one line item for each Specification Section.
1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of the Engineer.
 - c. Project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of both labor and materials.
 3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.
 4. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.
 5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.

Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.

6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Unit-Cost Allowances: Show the line-item value of unit-cost allowances, as a product of the unit cost, multiplied by the measured quantity. Estimate quantities from the best indication in the Contract Documents.
8. Schedule Updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.03 APPLICATIONS FOR PAYMENT:

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Engineer and paid for by the Owner. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
- B. Payment-Application Times: The date for each progress payment is the 15th day of each month. The period covered by each Application for Payment starts on the day following the end of the preceding period and ends 15 days prior to the date for each progress payment.
- C. Payment-Application Forms: Use forms provided by the Owner for Applications for Payment. Same copies are included in Section 00 62 76 - Application and Certificate for Progress Payment.
- D. Application Preparation: Complete every entry on the form. Include notarization and execution by a person authorized to sign legal documents on behalf of the Contractor. The Engineer will return incomplete applications without action.
 1. Entries shall match data on the Schedule of Values and the Contractor's Construction Schedule. Use updated schedules if revisions were made.
 2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application.
- E. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to NAU by a method ensuring receipt within 24 hours. One copy

shall be complete, including waivers of lien and similar attachments, when required.

- F. Waivers of Mechanics Lien: With each Application for Payment, submit waivers of mechanics liens from subcontractors, sub-subcontractors and suppliers for the construction period covered by the previous application.
1. Submit partial waivers on each item for the amount requested, prior to deduction for retainage, on each item.
 2. When an application shows completion of an item, submit final or full waivers for such items.
 3. Waiver Forms: Submit waivers of lien on forms provided herein, and executed as indicated.
 4. Waiver Forms: Submit waivers of lien on forms which comply with State statutes, and executed in a manner, acceptable to the Owner.
- G. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following:
1. List of subcontractors.
 2. List of principal suppliers and fabricators.
 3. Schedule of Values.
 4. Contractor's Construction Schedule (preliminary if not final).
 5. Schedule of principal products.
 6. Schedule of unit prices.
 7. Submittal Schedule (preliminary if not final).
 8. List of Contractor's staff assignments.
 9. List of Contractor's principal consultants.
 10. Copies of building permits.
 11. Copies of authorizations and licenses from governing authorities for performance of the Work.
 12. Initial progress report.

13. Report of preconstruction meeting.
 14. Certificates of insurance and insurance policies.
 15. Performance and payment bonds.
 16. Data needed to acquire the Owner's insurance.
 17. Initial settlement survey and damage report, if required.
- H. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.
1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
 2. Administrative actions and submittals that shall precede or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Test/adjust/balance records.
 - d. Maintenance instructions.
 - e. Meter readings.
 - f. Startup performance reports.
 - g. Changeover information related to Owner's occupancy, use, operation, and maintenance.
 - h. Final cleaning.
 - i. Application for reduction of retainage and consent of surety.
 - j. Advice on shifting insurance coverages.
 - k. Final progress photographs.
 - l. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion.

- I. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:
1. Completion of Project closeout requirements.
 2. Completion of items specified for completion after Substantial Completion.
 3. Ensure that unsettled claims will be settled.
 4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
 5. Transmittal of required Project construction records to the Owner.
 6. Certified property survey.
 7. Proof that taxes, fees, and similar obligations were paid.
 8. Removal of temporary facilities and services.
 9. Removal of surplus materials, rubbish, and similar elements.
 10. Change of door locks to Owner's access.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 13
CONSTRUCTION SCHEDULE

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Within ten (10) days after the Notice to Proceed, prepare and submit to the Engineer an estimated initial construction progress schedule for the work.
- B. Submit revised progress schedules on a monthly basis or as necessary.
- C. No partial payments shall be approved by the Engineer until there is an approved construction progress schedule on hand.
- D. The Contractor shall designate an authorized representative of his firm who shall be responsible for development and maintenance of the schedule and of progress and payment reports. This representative of the Contractor shall have direct project control and complete authority to act on behalf of the Contractor's schedule.

1.02 RELATED REQUIREMENTS

- A. Section 01 11 00: Summary of Work
- B. Section 01 31 19: Project Meetings

1.03 FORM OF SCHEDULES

- A. Prepare schedules in the form of a horizontal bar chart.
 - 1. Provide separate horizontal bar for each trade or operation within each structure or item.
 - 2. Horizontal time scale: in weeks from start of construction and identify the first work day of each month.
 - 3. Scale and spacing: allow space for notations and future revisions.
- B. Format of listings: the chronological order of the start of each item of work.
- C. Identification of listings: by major specification section numbers as applicable and structure.

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 of, and completion of, each major element of construction. Specifically list, but not limited to (shown in no particular order):
 - a. Permits and Shop Drawing Submittals
 - b. Ordering and Receiving of Materials and Equipment
 - c. Inspection of Existing Systems
 - d. Major Work Items including Installation of Equipment and Appurtenances
 - e. Testing
 - f. Restoration
 - g. Startup
 - h. As-built Drawings
3. Show projected dollar cash flow requirements for each month of construction.
4. Show projected manhour requirements for each month of construction.

B. Submittals Schedule for Shop Drawings. Show:

1. The dates for Contractor's submittals.
2. The dates submittals will be required for Owner furnished products, if applicable.
3. The dates approved submittals will be required from the Engineer. Allow no less than twenty-one (21) calendar days for review and approval of shop drawings and samples by the Engineer. No less than thirty (30) calendar days will be required for major equipment that requires review by more than one engineering discipline.

C. A list of all long lead items (equipment, materials, etc.).

1.05 PROGRESS REVISIONS

- A. Indicate progress of each activity to date of submission by shading a portion of the bar and showing percentage of completion. Show actual percentage of completion for each item as of the 20th day of each month during construction.
- B. Show changes occurring since previous submission of schedule:
 - 1. Major approved changes 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 subcontractors if applicable.

1.06 SUBMISSIONS

- A. Submit an initial schedule to the Engineer within ten (10) days after the Notice to Proceed.
 - 1. The Engineer will review schedules and return review copy within 15 days after receipt.
 - 2. If required, resubmit within five (5) days after return of review copy.
- B. Submit four (4) copies of revised monthly progress schedules with that month's application for payment.

1.07 DISTRIBUTION

- A. Distribute copies of the reviewed schedules to:
 - 1. Engineer.
 - 2. Job site file.

3. Subcontractors.
 4. Other concerned parties.
 5. Owner (two copies).
- B. Instruct recipients to report promptly to the Contractor, in writing, any problems anticipated by the projections shown in the schedules.

1.08 CHANGE ORDERS

- A. Upon approval of a change order, the approved changes shall be reflected in the next scheduled revision or update submittal by Contractor.

1.09 SCHEDULE MONITORING

- A. At not less than monthly intervals or when specifically requested by Engineer, Contractor shall submit to the Engineer of an updated schedule for those activities that remain to be completed.
- B. The updated schedule shall be submitted in the form, sequence, and number of copies requested for the initial schedule.

1.10 PROGRESS MEETINGS

- A. For the monthly progress meeting, Contractor shall submit a three (3) week look-ahead schedule showing all activities in progress, uncompleted or scheduled to be worked during the three weeks. The three (3) weeks include the current week plus the next two (2) weeks. All activities shall be from the approved schedule and must be as shown on the schedule unless behind or ahead of schedule.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1- GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. The Contractor shall cooperate and coordinate with NAU to schedule and administer the preconstruction meeting, periodic progress meetings, and specifically called meetings throughout the progress of the Work. The Contractor shall:
 - a. Prepare agenda for meetings.
2. Representatives of Contractor, subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
3. The Owner will attend meetings to ascertain that the Work is expedited consistent with Contract Documents and construction schedules.
4. The Engineer shall provide meeting minutes of the preconstruction meeting and each progress meeting in its entirety.

B. Related Requirements Described Elsewhere:

1. Construction Schedules: Section 01 31 13.

1.02 PRE-CONSTRUCTION

- A. A preconstruction conference will be scheduled after award of contract and prior to beginning work. This meeting shall be attended by Engineer of Record, the County, and an authorized representative of Contractor.
- B. Meeting will consider matters of contract administration and initial construction operations.
- C. Contractor shall submit proposed construction schedule prior to or at preconstruction conference; see Section 01 33 23.

1.03 PROGRESS MEETINGS

- A. Periodic progress meetings will be held at a time and place mutually agreed upon at preconstruction conference. A responsible representative of Contractor who can bind Contractor/subcontractor to decisions shall attend. A responsible representative of other subcontractors working on site shall also attend.
- B. Meetings will be held to coordinate and expedite progress of work and shall be conducted by Contractor. Contractor and each subcontractor on site shall submit a written report at each meeting indicating:
 - 1. Work progress since last meeting.
 - 2. Upcoming work sequences and schedules.
 - 3. Requests for information.
- C. Contractor shall record meeting minutes and shall distribute a written summary of items discussed to all parties involved in the project within 48 hours of each meeting. The written summary shall document all issues discussed and decisions reached at progress meeting.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 33

CONSTRUCTION PHOTOGRAPHS

PART 1- GENERAL

1.0.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for construction photographs.

1.0.2 SUBMITTALS

- A. Submit USB flash drive's as specified in Section 01 33 23, Submittals and in PART 3 - this Section.
- B. Photographer shall submit a digital sample set of the type and quality required during construction, for review and acceptance by Engineer.

1.0.3 QUALITY ASSURANCE

- A. All photographs shall be taken and processed by a qualified photographer with experience in construction photography.

PART 2- PRODUCTS

2.01 PHOTOGRAPHIC REQUIREMENTS

Specified in PART 3, this Section.

PART 3- EXECUTION

3.01. PHOTOGRAPHS

- A. Contractor shall be responsible for photographs along the entire construction site to show the existing and general condition of the site prior to construction. Each photo will be required to have a date stamp in the lower right corner.
- B. Photographs shall be taken of the following areas and at the following times.
 - 1. Existing Site conditions before Site work is started. Number of views shall be adequate to cover the Site.
 - 2. Finished Project after completion of Work. Number of views shall be adequate to show the finished Work. It is particularly important to provide a view of the restoration of the site upon completion of

construction.

3. If Project is not completed during the Contract Time or authorized extensions, photographs shall continue to be taken at no increase in Contract Price.

C. Digital Images

1. Submit two (2) complete sets of digital image electronic files on a USB flash drive prior to starting work.
 - a. Provide images in JPEG format, with minimum 150 dpi resolutions.
 - b. Submit images that have same aspect ratio as the sensor, uncropped.
 - c. The photos shall be labeled electronically on each photograph. The label shall contain the Project Name and Number, date of exposure, and description of view.
 - d. Each disk submitted shall be labeled with Project name
 - e. Identify electronic media with date digital photographs were taken

D. Deliver prints to Engineer.

END OF SECTION

SECTION 01 33 23

SUBMITTALS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Administrative and procedural requirements for submittals required for performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Shop Drawings.
 - 3. Product Data.
 - 4. Samples.
 - 5. Quality assurance submittals.

1.02 DEFINITIONS:

- A. Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.
- B. Field samples are full-size physical examples erected on-site to illustrate finishes, coatings, or finish materials. Field samples are used to establish the standard by which the Work will be judged.
- C. Mockups are full-size assemblies for review of construction, coordination, testing, or operation; they are not Samples.

1.03 SUBMITTAL PROCEDURES:

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review

submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

3. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.
 - a. Allow 15 working days for initial review. Allow additional time if the Engineer must delay processing to permit coordination with subsequent submittals.
 - b. If an intermediate submittal is necessary, process the same as the initial submittal.
 - c. Allow 15 working days for reprocessing each submittal.
 - d. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

B. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. Provide a space approximately 4 by 5 inches (100 by 125 mm) on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.
2. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of the Engineer.
 - d. Name and address of the Contractor.
 - e. Name and address of the subcontractor.
 - f. Name and address of the supplier.
 - g. Name of the manufacturer.

- h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
 - C. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the Contractor to the Engineer using a transmittal form. The Engineer will not accept submittals received from sources other than the Contractor without Contractor's review and approval markings and the action taken.
 - D. Provide required Product Code Certification with Shop Drawings. Submittals that do not have Product Code Certification included will be returned for resubmission.

1.04 SHOP DRAWINGS:

- A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents.
 - 1. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings.
 - 2. Standard information prepared without specific reference to the Project is not a Shop Drawing.
- B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:
 - 1. Dimensions.
 - 2. Identification of products and materials included by sheet and detail number.
 - 3. Compliance with specified standards.
 - 4. Notation of coordination requirements.
 - 5. Notation of dimensions established by field measurement.
 - 6. Do not use Shop Drawings without an appropriate final stamp indicating action taken.
- C. Submittals: Submit one reproducible and one blue- or black line print; the reproducible will be returned.

1.05 PRODUCT DATA:

- A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
 - 1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Product Data not so marked will be returned without review. Include the following information:
 - a. Manufacturer's printed recommendations.
 - b. Compliance with trade association standards.
 - c. Compliance with recognized testing agency standards.
 - d. Application of testing agency labels and seals.
 - e. Notation of dimensions verified by field measurement.
 - f. Notation of coordination requirements.
 - 2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
- B. Submittals: Submit 2 copies of each required submittal; submit 4 copies where required for maintenance manuals. Submit additional copies as required by the Contractor for distribution. The Engineer will retain one and will return the others marked with action taken and corrections or modifications required.
- C. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities.

1.06 SAMPLES:

- A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.

1. Mount or display Samples in the manner to facilitate review of qualities indicated. Prepare Samples to match the Engineer's sample. Include the following:
 - a. Specification Section number and reference.
 - b. Generic description of the Sample.
 - c. Sample source.
 - d. Product name or name of the manufacturer.
 - e. Compliance with recognized standards.
 - f. Availability and delivery time.
 2. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the submittal and the actual component as delivered and installed.
 - a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least 3 multiple units that show approximate limits of the variations.
 - b. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
 3. Submit a full set of choices where Samples are submitted for selection of color, pattern, texture, or similar characteristics from a range of standard choices. The Architect will review and return preliminary submittals with the Architect's notation, indicating selection and other action.
 4. Maintain sets of Samples, as returned, at the Project Site, for quality comparisons throughout the course of construction.
- B. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the Work. Show distribution on transmittal forms.

1.07 QUALITY ASSURANCE SUBMITTALS:

- A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.
- B. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.
- C. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 01 Section "Quality Control."

1.08 ENGINEER'S ACTION:

- A. Except for submittals for the record or information, where action and return is required, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility regardless of action indicated.
- B. Action Stamp: The Engineer will stamp each submittal with a uniform, action stamp. The Engineer will mark the stamp appropriately to indicate the action taken. Do not use, or allow others to use, submittals marked "Not Approved, Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
- C. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Engineer will return the submittal marked "Action Not Required."
- D. Unsolicited Submittals: The Engineer will return unsolicited submittals to the sender without action.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 41 23

PERMITS AND FEES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. County Responsibilities: The County already obtained the FDEP construction permit.
- B. Contractor responsibilities: Obtain and pay for all other permits and licenses required by authorities having jurisdiction, including but not limited to: land clearing permit, NPDES Notice of Intent and dewatering permit.
- C. Contractor shall be responsible to adhere to all provisions, requirements, and cost contained in all permits applicable to this project.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 16
QUALITY CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Administrative and procedural requirements for quality control services and testing and inspection laboratory services.

1.02 GENERAL:

- A. Specific quality control requirements for individual construction activities are specified in the Sections that specify those activities. Those requirements, including inspections and tests, cover production of standard products as well as customized fabrication and installation procedures.
- B. Inspections, test and related actions specified are not intended to limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.
- C. Requirements for the Contractor to provide quality control services required by the Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.03 CONTRACTOR RESPONSIBILITIES:

- A. Provide inspections, tests and similar quality control services specified in individual Specification Sections as the Contractor's responsibility and as required by governing authorities; these services include those specified to be performed by an independent agency and not by the Contractor. Include costs for these services in the Contract Sum.
- B. Provide and pay for costs of retesting and other related costs when:
 - 1. Results of required inspections, tests or similar services prove unsatisfactory and do not indicate compliance with Contract Document requirements, regardless of whether the original test was the Contractor's responsibility.
 - 2. Construction is revised or replaced by the Contractor, where tests were required on original construction.
 - 3. Additional testing is needed or required by the Contractor.

4. Additional trips to the project are necessary by an agency when scheduled times for tests and inspections are cancelled and the agency is not notified sufficiently in advance of cancellation to avoid the trip.
- C. Cooperate with agencies performing required inspections, tests and similar services and provide reasonable auxiliary services as requested.
1. Notify the agency sufficiently in advance of operations to permit assignment of personnel.
 2. Provide access to the Work and furnish incidental labor and facilities necessary to facilitate inspections and tests.
 3. Take adequate quantities of representative samples of materials that require testing and assist the agency in taking samples.
 4. Provide facilities for storage and curing of test samples.
 5. Provide the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
 6. Secure and protect samples and test equipment at the Project site.
- D. Coordinate the sequence of activities to accommodate required services with a minimum of delay and coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
- E. Schedule times for inspections, tests, taking samples and similar activities.

1.04 OWNER RESPONSIBILITIES:

- A. Provide inspections, tests and similar quality control services specified, except where they are specifically indicated as the Contractor's responsibility or are provided by another identified entity.
1. Costs for these services are not included in the Contract Sum.
 2. The Owner will employ and pay for the services of an independent agency, testing laboratory or other qualified firm to perform the services required.
 3. The Owner reserves the right to contract an independent agency to conduct testing on any portion of the work.

1.05 TESTING AGENCIES RESPONSIBILITIES:

- A. Cooperate with the Engineer and Contractor in performance of their duties; provide qualified personnel to perform required inspections and tests.
- B. Notify the Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of their services.
- C. Agencies are not authorized to release, revoke, alter or enlarge requirements of the Contract Documents, or approve or accept any portion of the Work.
- D. Agencies shall not perform any duties of the Contractor.

1.06 SUBMITTALS:

- A. Independent testing agencies shall submit 2 copies of certified written reports of each inspection, test or similar service to the Engineer and to the Contractor.
- B. Report Data: Written reports of each inspection, test or similar service shall include:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making the inspection or test.
 - 6. Designation of the Work and test method.
 - 7. Identification of product and Specification Section.
 - 8. Complete inspection or test data.
 - 9. Test results and interpretations of test results.
 - 10. Ambient conditions at the time of sample-taking and testing.
 - 11. Comments or professional opinion as to whether inspected or tested Work complies with Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting.

1.07 QUALIFICATION OF SERVICE AGENCIES:

- A. Engage inspection and testing service agencies, including independent testing laboratories, which are prequalified as complying with "Recommended Requirements for Independent Laboratory Qualification" by the American Council of Independent Laboratories, and which specialize in the types of inspections and tests to be performed.
- B. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the State in which the Project is located.
- C. Inspection and testing agencies engaged by the Contractor shall be acceptable to Engineer and Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION:

- A. Upon completion of inspection, testing, sample-taking and similar services, repair damaged construction and restore substrates and finishes to eliminate deficiencies, including deficiencies in visual qualities of exposed finishes
- B. Protect construction exposed by or for quality control service activities, and protect repaired construction.
- C. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing or similar services.

END OF SECTION

SECTION 01 52 00

CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION: The following criteria shall govern the furnishing of and paying for temporary construction and service items. Such items shall be instituted at the beginning and maintained for the life of the work or until removal or termination is approved by the Engineer.

1.02 TEMPORARY FACILITIES:

- A. Drinking Water: The Contractor shall provide cool water with dispensing utilities.
- B. Construction Water: The Contractor shall provide temporary water for construction at the project site. The Contractor shall provide proper back flow devices in order to comply with regulations concerning back flow & cross connection.
- C. It shall be the Contractor's responsibility to provide temporary electrical power for construction purposes.
- D. Toilet Facilities: The Contractor shall furnish a portable, job-site toilet enclosure facility through a local company specializing and licensed in this business. The toilet enclosure shall be located on the project site at a point approved by the Owner. It shall be maintained daily by the supplying company and removed from the project site upon completion of the project.

1.03 SECURITY:

- A. General: The Contractor shall provide security, as necessary or required, to protect work and property at all times.
- B. Rodents and Other Pests: The Contractor, through debris removal, etc., shall control the creation of rodent or pest problems. Should such develop, the Contractor shall secure services of exterminator to control.
- C. Debris Control: Keep premises clean and free from accumulation of debris and rubbish. Provide trash and debris receptacles and require use. Remove from site at least weekly.
- D. Cleaning: As work is completed by trades, areas of work shall be cleaned in preparation for next trade, inspections or general safety of property and person.

- E. Project Safety: The Contractor shall comply with all applicable governmental and insuring company requirements relative to construction and project safety. Either the superintendent or another company representative on the site during all working hours, shall be trained in project safety and designated as Contractor's Safety Director.

1.04 QUALITY ASSURANCE:

- A. Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
 - 1. Building Code Requirements
 - 2. Health and Safety Regulations
 - 3. Utility Company Regulations
 - 4. Police, Fire Department and Rescue Squad Rules
 - 5. Environmental Protection Regulations

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 55 26

TRAFFIC REGULATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section covers procedures for developing and implementing traffic control and regulation measures and maintenance of traffic in and around the construction area to provide for safe and efficient protection and movement of vehicular and pedestrian traffic/through and adjacent to the construction area.

1.02 RELATED REQUIREMENTS

- A. All applicable Sections of the Specifications.
- B. Conditions of the Contract.
- C. Nassau County Road Closure Policy.

1.03 SUBMITTALS

- A. Before closing or restricting traffic flow through any thoroughfare, the Contractor will give written notice to and, if necessary, obtain a permit or permits from the duly constituted public authority having jurisdiction over the thoroughfare. Contractor will also notify the applicable law enforcement, fire, and emergency services having jurisdiction in the area. Notice will be given no less than 72 hours in advance of the time when it may be necessary in the process of construction to close or restrict traffic to such thoroughfare, or as may be otherwise required by the governing authority.

1.04 SITE CONDITIONS

- A. The Contractor will plan construction operations such that existing local traffic access and traffic within the Facility can be maintained and will maintain during the construction such barricades, lights, flagmen, and other protective devices as appropriate, whether specified for the project or required by the local governing authority. Traffic control devices used for maintenance of traffic will comply with the FDOT Manual.
- B. The Contractor will conduct his work in such manner as not to unduly or unnecessarily restrict or impede normal traffic through the streets of the community and within the Facility. Insofar as it is practicable, excavated material and spoil banks will not be located in such manner as to obstruct traffic. The traveled way of all streets, roads, alleys, reclamation facility's roads and

driveways will be kept clear and unobstructed insofar as is possible and will not be used for the storage of construction materials, equipment, supplies, or excavated earth, except when and where necessary if approved by the governing authority. If required by duly constituted public authority, the Contractor will, at his own expense, construct bridges or other temporary crossing structures over trenches so as not to unduly restrict traffic. Such structures will be of adequate strength and proper construction and will be maintained by the Contractor in such manner as not to constitute an undue traffic hazard. Private driveways will not be closed except when and where necessary, and then only upon due advance notice to the Owner and for the shortest practicable period of time consistent with efficient and expeditious construction. The Contractor will be liable for any damages to persons or property resulting from his work.

- C. The Contractor will make provisions at cross streets for the free passage of vehicles and foot passengers, either by bridging or otherwise, and will not obstruct the sidewalks, gutters, or streets, nor prevent in any manner the flow of water in the latter, but will use all proper and necessary means to permit the free passage of surface water along the gutters. The Contractor will immediately cart away all offensive matter, exercising such precaution as may be directed by the Owner.
- D. Unless otherwise required by the governing authority, maintenance of traffic in and around the construction zone will conform to Section 102 of the FDOT Specification, and Index Nos. 600, 620, 621, 622, 623, and 624 of the FDOT Standards.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 57 26

DUST CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

Limit blowing dust caused by construction operations by applying water or employing other appropriate means or methods to maintain dust control.

1.02 PROTECTION OF ADJACENT PROPERTY

- A. The bidders shall visit the site and note the buildings, landscaping, roads, parking areas and other facilities near the work site that may be damaged by their operations. The Contractor shall make adequate provision to fully protect the surrounding area and will be held fully responsible for all damages resulting from his operations.

- B. Dust, Fumes, Spray, or Spills:

Protect all existing facilities (indoors or out) from damage by the above hazards (indoors or out);

Protect motors, bearings, electrical gear, instrumentation, and building or other surfaces from dirt, dust, welding fumes, paint spray, spills or droppings causing wear, corrosion, malfunction, failure or defacement by enclosure, sprinkling or other dust palliatives, masking and covering, exhausting or containment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 65 00

DELIVERY, STORAGE AND HANDLING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the Work. Specific requirements, if any, are specified with the related item.

1.02 TRANSPORTATION AND DELIVERY

- A. Transport and handle items in accordance with manufacturer's instructions.
- B. Schedule delivery to reduce long term onsite storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.
- C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.
- D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.
- E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- F. Provide necessary equipment and personnel to unload all items delivered to the site. Delivery shall not be accepted by Owner's personnel.
- G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e. Owner, other contractors), notify Engineer verbally, and in writing, of any problems.

1.03 STORAGE AND PROTECTION

- A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the

Contractor. Instructions shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.

- B. Store loose granular materials on solid flat surface in a well-drained area. Prevent mixing with foreign matter.
- C. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulation of dirt or grease, and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in manner to reduce breakage, cracking and spalling to a minimum.
- D. Mechanical, electrical equipment and instruments are subject to corrosive damage by the atmosphere if stored outdoors, even when covered by canvas. Such materials shall be stored in a weather-tight building to prevent corrosive or other heat and moisture related damage. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturers of the equipment to be stored.
 - 1. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

1.04 STORAGE AND HANDLING OF EQUIPMENT ON SITE

- A. Because of the long period allowed for construction, special attention shall be given to the storage and handling of equipment on site. As a minimum, the procedure outlined below shall be followed:
 - 1. Materials shall not be shipped until approved by the Engineer. The intent of this requirement is to avoid unnecessary delivery of unapproved materials and to reduce on-site storage time prior to installation and/or operation. Under no circumstances shall major equipment or finish

products be delivered to the site more than one month prior to installation without written authorization from the Engineer. Materials shipped to the site, or temporarily stored off-site in approved locations, shall be stored in accordance with Paragraph 1.04, herein.

2. All equipment having moving parts such as gears, electric motors, etc. and/or instruments shall be stored in a temperature and humidity-controlled building approved by the Engineer, until such time as the equipment is to be installed.
3. All equipment shall be stored fully lubricated with oil, grease, etc. unless otherwise instructed by the manufacturer.
4. Manufacturer's storage instructions shall be carefully studied by the Contractor and reviewed with the Engineer by him. These instructions shall be carefully followed and a written record of this kept by the Contractor.
5. Moving parts shall be rotated a minimum of once weekly to insure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half the load, once weekly for an adequate period of time to insure that the equipment does not deteriorate from lack of use.
6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety (90) days, shall have the bearings cleaned, flushed and lubricated prior to testing and startup, at no extra cost to the Owner.
7. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equivalent to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

1.05 SPARE PARTS

- A. Spare parts for certain equipment provided under Divisions 33: Utilities has been specified in the pertinent sections of the Specifications. The Contractor shall collect and store all spare parts so required in an area to be designated by the

Engineer. In addition, the Contractor shall furnish to the Engineer an inventory listing all spare parts, the equipment they are associated with, the name and address of the supplier, and the delivered cost of each item. Copies of actual invoices for each item shall be furnished with the inventory to substantiate the delivered cost.

1.06 GREASE, OIL AND FUEL

- A. All grease, oil and fuel required for testing of equipment shall be furnished with the respective equipment. The Owner shall be furnished with a year's supply of require lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied.
- B. The Contractor shall be responsible for changing the oil in all drives and intermediate drives of each mechanical equipment after initial break-in of the equipment, which in no event shall be any longer than three (3) weeks of operation. This shall be completed prior to release of retainage.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 74 30

PRESSURE TESTING OF PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: This section specifies the leakage testing requirements for piping.
- B. Test Pressures: Test pressures for the piping shall be as specified in the pertinent sections of the project specifications.
- C. Test Method: Test Method for the piping shall be as specified in the pertinent sections in the project specifications.
- D. Testing Records:
 - 1. Provide a record of each piping installation during the testing. These records shall include:
 - a) Date of test.
 - b) Identification of pipeline tested or retested.
 - c) Identification of pipeline material.
 - d) Identification of pipe specification.
 - e) Test fluid.
 - f) Test pressure.
 - g) Remarks: Leaks identified (type and location), types of repairs, or corrections made.
 - h) Certification by Contractor that the leakage rate measured conformed to the Specifications.
 - i) Signature of Owner's representative witnessing pipe test.
 - 2. Submit three (3) copies of the test records to the Engineer's representative upon completion of the testing.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Testing fluid shall be air for pneumatic test.

2.02 MATERIALS AND EQUIPMENT

- A. Provide pressure gauges, pipes, bulkheads, air compressor, and meters to perform the pneumatic testing.

PART 3 - EXECUTION

3.01 TESTING PREPARATION

- A. Pipes shall be in place and anchored before commencing pressure testing.
- B. Conduct pneumatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.
- C. Before conducting pneumatic tests, blow air through the pipes to remove dirt and debris.
- D. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.
- E. Pressure Test:
 - 1. All tests shall be made in the presence of and to the satisfaction of the Owner or Engineer and also, to the satisfaction of any local or state inspector having jurisdiction.
 - a. Provide not less than three (3) days notice to the Owner, Engineer, and the authority having jurisdiction when it is proposed to make the tests.
 - b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.
 - c. The piping systems may be tested in sections as the work progresses, but no joint or portion of the system shall be left untested.

2. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.
3. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

3.02 INSPECTION AND TESTING

- A. Hydrostatic Testing of Aboveground and Exposed Piping: Open vents at high points of the piping system to purge air while the pipe is being filled. Subject the piping system to the test pressure of 150-psi unless otherwise noted. Maintain the test pressure for a minimum of 2 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show no leakage or weeping. Correct leaks and retest until no leakage is obtained.
- B. Hydrostatic Testing of Buried Piping:
 1. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortar-lined piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.
 2. Test Pressure: 50 percent (50%) above the normal working pressure, but not less than 150-psi, unless otherwise noted on the Contract Drawings.
 3. Apply and maintain the test pressure by means of a hydraulic force pump. Maintain the test pressure for a minimum duration of 2 hours. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure during the 2 hours. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula.

$$L = \frac{SD(P)^{1/2}T}{133,200}$$

in which:

L = Allowable Leakage During the Test Period (gallons)

S = Length of Pipe Tested (feet)

D = Diameter of the Pipe (inches)

P = Specified Test Pressure (psig)

T = Specified Time (hours)

4. Visible Leakage: All leaks evident at the surface shall be repaired and leakage eliminated regardless of the measured total leakage.

5. Leakage Measurement: The amount of water required to maintain the test pressure is the leakage.
6. Repair and retest any pipes showing leakage rates greater than that allowed.
7. Leakage Repair: Repairs to leaks shall be completed in strict accordance with the pipe manufacturer's written recommendations.

C. Pneumatic Testing:

1. Test Pressure: Minimum 1.2 times working pressure and maximum 1.5 times working pressure
2. Perform pneumatic testing using air. Perform tests only after the piping has been completely installed including supports, hangers, and anchors. Protect test personnel and Owner's operating personnel. Secure piping to be tested to prevent the pipe from moving and to prevent damage to adjacent piping and equipment. Remove or isolate from the pipe any appurtenant instruments or devices that could be damaged by the test, prior to applying the test.
3. Apply an initial pneumatic leakage test of 25 psig to the piping system prior to final leak testing. Examine for leakage, detected by soap bubbles, at joints and connections. After correcting visible leaks, gradually increase the pressure in the system to not more than one-half of the test pressure. Then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure has been reached. Continuously maintain the pneumatic test pressure for a minimum time of four hours and for such additional time as may be necessary to conduct a soap bubble examination for leakage. The piping system shall show no leakage. Correct any visible leakage and retest. The system shall be completely retested until the entire system is free from detectable leakage.

END OF SECTION

SECTION 01 77 19
PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Administrative and procedural requirements for project closeout.
 - 1. Inspection procedures.
 - 2. Project record document submittal.
 - 3. Final cleaning.

1.02 SUBSTANTIAL COMPLETION:

- A. Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
 - 2. Advise Owner of pending insurance change-over requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents - refer to Section 01 78 36 Warranties and Bonds.
 - 4. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities; include occupancy permits, operating certificates and similar releases.
 - 5. Submit record drawings, maintenance manuals, and similar final record information.
 - 6. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
 - 7. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

- B. When the Contractor considers the Work to be substantially complete, he shall submit a written notice to the Engineer that the Work, or designated portion of the Work, is complete and ready for inspection.
- C. Within 5 days of receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfulfilled requirements. When the Engineer and Owner concur that the Work, or designated portion of the Work, is substantially complete, the Engineer will prepare the Certificate of Substantial Completion following inspection.
- D. Should the Engineer determine that the Work is not substantially complete, he will advise the Contractor of construction or other requirements that must be completed or corrected before the certificate will be issued.
 - 1. The Engineer will repeat inspection when requested and assured that the Work has been substantially completed.
 - 2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.03 FINAL COMPLETION:

- A. When Contractor considers the Work to be complete, he shall submit written certification to the Engineer that the Work is completed and ready for final inspection. Include the following:
 - 1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations.
 - 2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 - 3. Submit a certified copy of the Engineer's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by the Engineer.
 - 4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion, or when the Owner took possession of and responsibility for corresponding elements of the Work.
 - 5. Submit consent of surety to final payment.

6. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. The Engineer will inspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to the Engineer.
1. Upon completion of inspection, the Engineer will prepare a certificate of final acceptance, or advise the Contractor of Work that is incomplete, or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, reinspection process will be repeated.

1.04 RECORD DOCUMENT SUBMITTALS:

- A. Maintain at the site one complete set of record documents; protect from deterioration and loss in a secure, fire-resistive location.
1. Provide access to record documents for the Engineer's reference during normal working hours.
 2. Label each document "PROJECT RECORD" in 2 inch high printed letters.
 3. Do not use for construction purposes.
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
 2. Mark new information that was not shown on Contract Drawings or Shop Drawings.
 3. Show horizontal control dimensions in two directions at right angles for each underground fitting, valve, and appurtenance. Horizontal control dimensions shall be tied to a permanent above ground marker such as a building or tank slab. Show elevations of storm sewers, gravity sewers including laterals, electric cables, television cables, telephone cables, force mains, water mains crossed, and any other underground utilities and structures. Information shall

be obtained by surveying by a professional engineer or land surveyor registered in the State of Florida.

4. Note related Change Order numbers where applicable.
 5. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
- C. Record Specifications: Maintain one complete copy of the Project Manual, including addenda, and one copy of other written construction documents such as Change Orders and modifications issued in printed form during construction.
1. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
 2. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation.
 3. Note related record drawing information and Product Data.
- D. Record Product Data: Maintain one copy of each Product Data submittal.
1. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site, and from the manufacturer's installation instructions and recommendations.
 2. Give particular attention to concealed products and portions of the Work which cannot otherwise be readily discerned later by direct observation.
 3. Note related Change Orders and mark-up of record drawings and Specifications.
- E. Record Sample Submitted: Immediately prior to the date or dates of Substantial Completion, the Contractor will meet at the site with the Engineer and the Owner to determine which of the submitted Samples that have been maintained during progress of the Work are to be transmitted to the Owner for record purposes. Comply with delivery to the Owner's Sample storage area.
- F. Record Survey: Provide as-built survey prepared in accordance with the minimum technical standards for surveying as set forth by the Florida Board of Professional Surveyors and Mappers in Chapter 61G17-6 Florida Administrative Code, pursuant to Section 472.027 Florida Statutes.

- G. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the Work.
- H. At Contract close-out, deliver one copy of Record Documents to Engineer for Owner. Accompany submittal with transmittal letter in duplicate containing the following information:
 - 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

3.01 FINAL CLEANING:

- A. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program.
- B. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion and maintain until final completion, except in areas occupied or designated by Owner.
 - 1. Remove labels that are not permanent labels.
 - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition.
 - 4. Leave concrete floors broom clean.
 - 5. Vacuum carpeted surfaces.

6. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances.
 7. Clean plumbing fixtures to a sanitary condition.
 8. Clean light fixtures and lamps.
 9. Clean the site, including landscape development areas, of rubbish, litter and other foreign substances.
 10. Sweep paved areas broom clean; remove stains, spills and other foreign deposits.
 11. Rake grounds that are neither paved nor planted, to a smooth even-textured surface.
- C. Remove temporary protection and facilities installed for protection of the Work during construction.
- D. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove waste materials from the site and dispose of in a lawful manner.
- E. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

END OF SECTION

SECTION 01 78 23

OPERATING AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under Contract.
 - a. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of Specifications.
2. Instruct Owner's personnel in maintenance of products and in operation of equipment and systems.

B. Related Requirements Described Elsewhere:

1. Project Closeout: Section 01 77 19

1.02 QUALITY ASSURANCE

A. Preparation of data shall be done by personnel:

1. Trained and experienced in maintenance and operation of described products.
2. Familiar with requirements of this Section.
3. Skilled as technical writer to the extent required to communicate essential data.
4. Skilled as draftsman competent to prepare required drawings.

1.03 FORM OF SUBMITTALS

A. Prepare data in form of an instructional manual for use by Owner's personnel.

B. Format:

1. Size: 8-1/2 inches x 11 inches.
2. Paper: 20 pound minimum, white, for typed pages.

3. Text: Manufacturer's printed data.
4. Drawings:
 - a. Provide reinforced punched binder tab, bind in with text.
 - b. Reduce larger drawings and fold to size of text pages but not larger than 14 inches x 17 inches.
5. Provide fly-leaf for each separate product, or each piece of operating equipment.
 - a. Provide typed description of projects and major component parts of equipment.
 - b. Provide identification tabs.
6. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List:
 - a. Title of Project.
 - b. Identity of separate structure as applicable.
 - c. Identity of general subject matter covered in the manual.

C. Binders:

1. Commercial quality , three D-ring type binders with durable and cleanable white plastic covers. 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.
2. Maximum D-ring width: 2 inches.
3. When multiple binders are used, correlate the data into related consistent groupings.

- D. In addition to standard operation and maintenance manuals, all manufacturers supplying equipment specified in Division 33 shall submit their operation and maintenance manuals on magnetic media/floppy disks in Microsoft Word, WordPerfect or text, ".txt" formats. All graphic files shall be in BMP, PCS, CDR, JPEG, DWG, DXF or PDF formats.

1.04 CONTENT OF MANUAL

- A. Neatly typewritten table of contents for each volume, arranged in systematic order.
 - 1. Contractor, name of responsible principal, address and telephone number.
 - 2. A list of each product required to be included, indexed to content of the volume.
 - 3. List, with each product, name, address and telephone number of:
 - a. Subcontractor, manufacturer and installer name, addresses and telephone numbers.
 - b. A list of each product required to be included, indexed to content of the volume.
 - c. Identify area of responsibility of each.
 - d. Local source of supply for parts and replacement equipment including name, address and telephone number.
 - 4. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
- B. Product Data:
 - 1. Include only those sheets which are pertinent to the specific product.
 - 2. Annotate each sheet to:
 - a. Clearly identify specific product or part installed.
 - b. Clearly identify data applicable to installation.
 - c. Delete references to inapplicable information.
 - 3. Operation and maintenance information as herein specified.
 - 4. Record shop drawings as submitted and approved with all corrections made for each product.

- C. Drawings:
 - 1. Supplement product data with drawings as necessary to clearly illustrate:
 - a. Relations of component parts of equipment and systems.
 - b. Control and flow diagrams.
 - 2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
 - 3. Do not use Project Record Documents as maintenance drawings.
- D. Written test, as required to supplement product data for the particular installation:
 - 1. Organize in consistent format under separate headings for different procedures.
 - 2. Provide logical sequence of instruction of each procedure.
- E. Copy of each warranty, bond and service contract issued.
 - 1. Provide information sheet for Owner's personnel, give:
 - a. Proper procedures in event of failure.
 - b. Instances which might affect validity of warranties or bonds.

1.05 MANUAL FOR MATERIALS AND FINISHES

- A. Submit six (6) copies of complete manual in final form.
- B. Content: for architectural products, applied materials and finishes:
 - 1. Manufacturer's data, giving full information on products.
 - a. Catalog number, size, composition.
 - b. Color and texture designations.
 - c. Information required for reordering special manufacturing products.

2. Instructions for care and maintenance.
 - a. Manufacturer's recommendation for types of cleaning agents and methods.
 - b. Cautions against cleaning agents and methods which are detrimental to product.
 - c. Recommended schedule for cleaning and maintenance.
- C. Content, for moisture protection and weather-exposed products:
 1. Manufacturer's data, giving full information on products.
 - a. Applicable standards.
 - b. Chemical composition.
 - c. Details of installation.
 2. Instructions for inspection, maintenance and repair.
- D. Additional requirements for maintenance data: Respective sections of Specifications.

1.06 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit six (6) copies of complete manual in final form.
- B. Content, for each unit of equipment and system, as appropriate:
 1. Description of unit and component parts.
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Summary of information listed on equipment and motor data plates.
 2. Operating procedures:
 - a. Start-up, break-in, routine and normal operating instructions.

- b. Regulation, control, stopping, shut-down and emergency instructions.
 - c. Summer and winter operating instructions.
 - d. Special operating instructions.
- 3. Maintenance procedures:
 - a. Routine operations.
 - b. Guide to "trouble-shooting".
 - c. Disassembly, repair and reassembly.
 - d. Alignment, adjusting and checking.
- 4. Servicing and lubrication required.
- 5. Manufacturer's printed operating and maintenance instructions.
- 6. Description of sequence of operation by control manufacturer.
- 7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
 - a. Predicted life of parts subject to wear.
 - b. Items recommended to be stocked as spare parts.
- 8. As-installed control diagrams by controls manufacturer.
- 9. Each Contractor's coordination drawings.
 - a. As-installed color coded piping diagrams.
- 10. Charts of valve tag numbers, with location and function of each valve.
- 11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.
- 12. Other data as required under pertinent sections of specifications.

13. Approved record shop drawings with all corrections made, and a copy of the warranty statement, checkout memo, demonstration test procedures and demonstration test certification.
- C. Content, for each electric and electronic systems, as appropriate:
1. Description of system and component parts.
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 2. Circuit directories and panel boards.
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
 3. As installed color coded wiring diagrams.
 4. Operating procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Special operating instructions.
 5. Maintenance procedures:
 - a. Routine operations.
 - b. Guide to "trouble-shooting".
 - c. Disassembly, repair and reassembly.
 - d. Adjustment and checking.
 6. Manufacturer's printed operating and maintenance instructions.
 7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

- 8. Other data as required under pertinent sections of specifications.
- D. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
- E. Additional requirements for operating and maintenance data: Respective sections of Specifications.

1.07 SUBMITTAL SCHEDULE

- A. Submit two (2) copies of preliminary draft of proposed formats and outlines of contents of Operation and Maintenance Manuals within 90 days after Notice to Proceed.
- B. Submit two (2) copies of completed data in preliminary form no later than 20 days following Engineer's review of the last shop drawing of a product and/or other submittal specified under Section 01 33 23, but no later than delivery of equipment. One (1) copy will be returned with comments to be incorporated into the final copies and the other copy will be retained on-site for use in any early training.
- C. Submit six (6) copies of approved manual in final form directly to the offices of the Engineer, GAI Consultants, Inc., within 10 days after the reviewed copy or last item of the reviewed copy is returned.
- D. Provide six (6) copies of addenda to the operation and maintenance manuals as applicable and certificates as specified within 30 days after final inspection.

1.08 INSTRUCTION OF OWNER'S PERSONNEL

- A. Prior to demonstration test, fully instruct Owner's designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.
- B. Operating and maintenance manual shall constitute the basis of instruction. Review contents of manual with Owner's operating and maintenance personnel in full detail to explain all aspects of operations and maintenance.
- C. Instructors shall be fully qualified personnel as outlined within the individual equipment specifications. If no specific training specifications are listed with the equipment, the Contractor shall provide the instruction with qualified Contractor personnel.
- D. The Contractor shall provide a list to the Owner indicating the date, time and instructors that will be present for all training sessions.

- E. The instructors shall provide for and prepare lesson scopes and handouts for up to five individuals designated by the Owner that outline the items to be covered. Separate sessions for operation and maintenance instruction shall be provided consecutively. Handouts shall be submitted to the Owner with at least one week's notice prior to the training sessions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 78 36

WARRANTIES AND BONDS

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS:

- A. General provisions of Contract, including General and Supplementary Conditions.
- B. Warranties and certificates for specific products - Respective Specification Sections.
- C. Project Closeout - Section 01 77 19.

1.02 SECTION INCLUDES:

- A. Administrative and procedural requirements for warranties, bonds, and certifications required by the Contract Documents, including Owner's Standard Maintenance Warranty Bond, manufacturers' standard warranties on products and special warranties.

1.03 WARRANTY REQUIREMENTS:

- A. Contractor shall warrant all work covered under this Agreement to be free from defects for a period of 2-years after the date of Substantial Completion.
- B. When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work or abandon in-place if acceptable to Owner in a manner that is acceptable to Owner.
- C. When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- D. Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- E. Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available

under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

- F. The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- G. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.04 SUBMITTALS:

- A. Submit written warranties to the Owner before requesting inspection for Substantial Completion. If the Owner's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner.
- B. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Owner within fifteen days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner for approval prior to final execution.
- D. Provide written certifications of compliance and other commitments and agreements for continuing services in a form which includes all pertinent information including:
 - 1. Quantities and dates of shipments.
 - 2. Attestment that materials incorporated into the Work comply with specified requirements. Certification shall not be construed as relieving the Contractor from furnishing satisfactory materials, if the material is later found to not meet specified requirements.
 - 3. Signature of officer of company.

4. Laboratory test reports submitted with certificates of compliance shall show dates of testing, specification requirements under which testing was performed, and results of tests.
- E. Refer to individual Sections of Divisions 02 through 33 for specific content requirements, and particular requirements for submittal of special warranties.
- F. Form of Submittal:
1. Compile 3 copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer.
 2. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 3. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2 in. by 11 in. paper.
 4. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
 5. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the Project title or name, and the name of the Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 91 14

START-UP AND DEMONSTRATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Demonstrate to Owner and Engineer that the Work functions as a complete and operable system under normal and emergency operating conditions.
- B. Contractor shall provide all materials, personnel, equipment and expendables as needed and as specified to perform the required start-up and demonstration tests.

PART 2 - PRODUCTS

2.01 START-UP PLAN

- A. Submit for approval by the Engineer a detailed start-up plan outlining the schedule and sequence of all tests and start-up activities, including submittal of checkout forms, submittal of demonstration test procedures, start-up, demonstration and testing, submittal of certification of completed demonstration and training. Start-up and commissioning may not begin until the plan is approved by the Engineer.

PART 3 - EXECUTION

3.01 COMPONENT TEST AND CHECK-OUT

- A. Start-up Certification: Prior to system start-up, successfully complete all the testing required of the individual components of the Work. Submit six (6) copies of CHECK-OUT MEMO'S for each individual component or piece of equipment, signed by the Contractor or the subcontractor and the manufacturer's representative. All copies of the Operation and Maintenance Manuals must be provided before start-up may begin. These forms shall be completed and submitted before Instruction in Operation to Owner or a request for initiating any final inspections. Insert one (1) copy of this form into the applicable section of each Operation and Maintenance Manual.
- B. Demonstrate to the Engineer and the Owner's representative, that all temporary jumpers and/or bypasses have been removed and that all of the components are operating under their own controls as designated.
- C. Coordinate start-up activities with the Owner's operating personnel at the treatment plant site and with the Engineer prior to commencing system start-up.

3.02 START-UP

- A. Confirm that all equipment is properly energized, that the valves are set to their normal operating condition and that the flow path through the new Work is unobstructed.
- B. Slowly fill each hydrostatic structure in the process flow stream with water.
- C. Initiate start-up and training in accordance with and with the use of the plant operation and maintenance manuals.
- D. Observe the component operation and make adjustments as necessary to optimize the performance of the Work.
- E. Coordinate with Owner for any adjustments desired or operational problems requiring debugging.
- F. Make adjustments as necessary.

3.03 START-UP DEMONSTRATION AND TESTING

- A. After all Work components have been constructed, field tested, and started up in accordance with the individual Specifications and manufacturer requirements, and after all Check-Out Forms have been completed and submitted, perform the Start-Up Demonstration and Testing. The demonstration period shall be held upon completion of all systems at a starting date to be agreed upon in writing by the Owner or his representative. Prior to beginning the start-up demonstration testing, the Contractor shall submit a detailed schedule of operational circumstances for approval by the Engineer. The schedule of operational circumstances shall describe, in detail, the proposed test procedures for each piece of equipment. Provide similar test procedure forms for each piece of equipment or section of the Work to include all particular aspects and features of that equipment or section of the Work and as specified in the Technical Sections of the Specifications.
- B. The Start-Up Demonstration Testing will be conducted for five (5) consecutive days. The Work must operate successfully during the five (5) day testing period in the manner intended. If the Work does not operate successfully, or if the start-up is interrupted due to other contracts, the problems will be corrected and the test will start over from day one. The party causing the interruption will be subject to the assessment of actual damages due to delay.
- C. During the start-up demonstration period, operate the Work, instruct designated plant operating personnel in the function and operation of the Work, and cause various operational circumstances to occur. As a minimum, these circumstances will include average and peak daily flows, random equipment or process failures,

tank overflows, surcharges, interlocks and bypasses. Demonstrate the essential features of the equipment and its relationship to other equipment. The approved schedule of operational circumstances and Demonstration Test Procedures Forms will be used as the agenda during the Start-Up Demonstration Testing period for all equipment and sections of the Work. Coordination of the demonstration test schedule will be accomplished through the Engineer.

- D. Acceptability of the Work's performance will be based on the Work performing as specified under these actual and simulated operating conditions, to provide water treatment facilities functioning as intended and as defined in the Contract Documents. The intent of the start-up demonstration and testing is for the Contractor to demonstrate to the Owner and the Engineer that the Work will function as a complete and operable system under normal, as well as emergency operating conditions, and is ready for final acceptance.
- E. Demonstrate the essential features of all the mechanical systems including, but not limited to, the following as they apply to the Work. Each system shall be demonstrated once only, after completion of satisfactory testing.
- F. Demonstrate the essential features of all electrical and instrumentation systems including, but not limited to, the following as they apply to the work:
 - 1. Electrical systems controls and equipment.
 - 2. Supervisory control and data acquisition system.
 - 3. Communications systems.
 - 4. Lighting fixtures (including relamping and replacing lenses).
 - a. Exit and safety fixtures.
 - b. Fixtures, indoor and outdoor.
 - c. Floodlighting.
 - 5. Panelboards.
 - a. Distribution panels.
 - b. Lighting panels.
 - c. Main panels, power panels.
 - d. Switchboard.
 - 6. Generator Transfer Switch (automatic).

7. Wiring devices.
 - a. Face plates.
 - b. Low-voltage controls.
 - c. Outlets: convenience, special purpose.
 - d. Switches: regular, time.
- G. Upon successful completion of the Start-up, Demonstration and Testing, the Owner's personnel will receive the specified training for each system. Training of the Owner's personnel will not be considered valid unless it takes place using a system that has successfully passed the Start-up, Demonstration and Testing.
- H. Upon completion of all specified operator training, the Contractor shall submit to the Engineer six (6) copies of the Certificate of Completed Demonstration Form, for each item of equipment or system in the Work, signed by the Contractor, Subcontractor, Engineer, and the Owner. Insert one (1) copy of this form in the applicable section of each Operation and Maintenance Manual. A sample Certificate of Completed Demonstration Form is attached.

CERTIFICATE OF COMPLETED DEMONSTRATION FORM

☐ OWNER _____	No. Copies _____	CERTIFICATE OF COMPLETED DEMONSTRATION MEMO NO. _____
☐ ENGINEER: _____	No. Copies _____	
☐ ARCHITECT: _____	No. Copies _____	
☐ CONTRACTOR: _____	No. Copies _____	
☐ FIELD: _____	No. Copies _____	
☐ OTHER: _____	No. Copies _____	

PROJECT DATA

NAME: NAU WWTF
LOCATION: _____
OWNER: _____
OTHER: _____

CONTRACT DATA

NUMBER: _____
DATE: _____
DRAWING NO: _____
SPECIFICATION
SECTION: _____

NOTE TO CONTRACTOR:

Submit five (5) copies of all information listed below for checking at least one (1) week before scheduled demonstration of the Work. After all information has been approved by the Engineer, give the Owner a Demonstration of Completed Systems as specified and have the Owner sign five (5) copies of this form. After this has been done, a written request for a final inspection of the system shall be made.

MEMORANDUM:

This memo is for the information of all concerned that the Owner has been given a Demonstration of Completed Systems on the work covered under this Specification Section. This conference consisted of the system operation, a tour on which all major items of equipment were explained and demonstrated, and the following items were given to the Owner:

- (a) Owner's copy of Operation and Maintenance Manual for equipment or systems specified under this Section containing approved submittal sheets on all items, including the following:
 - (1) Maintenance information published by manufacturer on equipment items.
 - (2) Printed warranties by manufacturers of equipment items.
 - (3) Performance verification information as recorded by the Contractor.
 - (4) Check-Out Memo on equipment by manufacturer's representative.
 - (5) Written operating instructions on any specialized items.
 - (6) Explanation of guarantees and warranties on the system.
- (b) Prints showing actual "As-Built" conditions.

- (c) A demonstration of the system in operation and of the maintenance procedures which will be required.

(Name of General Contractor)

By: _____
(Authorized Signature, Title and Date)

(Name of Subcontractor)

By: _____
(Authorized Signature, Title and Date)

Operation and Maintenance Manuals, Instruction Prints, Demonstration and Instruction in Operation Received:

(Name of Owner)

By: _____
(Authorized Signature/Title/Date)

END OF SECTION

SECTION 02 24 00

STABILIZED SUBGRADE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work specified in this Section consists of the construction of a stabilized roadway subgrade where indicated on the Drawings. Construction shall be to the uniformity, density and bearing ratio specified hereinafter. Parking areas shall be stabilized to a minimum depth of 12 inches below the bottom grade of the base material and to a width 6 inches outside each pavement or concrete curb edge. Roadways and streets shall be stabilized to the depths and dimensions indicated on the Drawings.
- B. Definitions: The stabilizing shall be Florida Department of Transportation (FDOT) Type B as described hereinafter. The required bearing ratio value shall be obtained either by constructing the subgrade or selected materials from the roadway and borrow area(s), or by stabilizing the subgrade material by the addition and mixing in of suitable stabilizing material. Such work shall be done in accordance with these specifications, lines, grades, thicknesses and notes shown on the Drawings.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The particular type of stabilizing material to be used shall be in accordance with Paragraph 2.02.D hereinafter and shall meet the following requirements.

2.02 MATERIALS AND EQUIPMENT

- A. Use of Materials from Existing Base:
 - 1. When the utilization of materials from an existing base is called for, (as all, or a portion, of the stabilizing additives) the Engineer will direct the locations, placing and distribution of such materials, and this work shall be done prior to the spreading of any additional commercial or local materials. Removal of any section of existing base will not be required until the need for it in maintaining traffic is fulfilled.
 - 2. The utilization of materials from an existing base may be called for in combination with the designated type of stabilizing.
- B. Commercial Materials:

1. General: Materials which are designated as Commercial Materials which are to be used for this stabilizing may be either commercial limerock or limerock overburden.
2. Limerock: Specific requirements for limerock and limerock overburden: For limerock and limerock overburden, the percentage of carbonates of calcium and magnesium shall be at least 70, and the plasticity index shall not exceed 10. The gradation of both commercial limerock and limerock overburden shall be such that 97 percent (97%) of these materials will pass a 1-1/2 inch sieve.

C. Local Material:

1. General: Local materials used for this stabilizing may be high-bearing value soils or sand-clay material. The material passing the 40-mesh sieve shall have a liquid not greater than 30 and a plasticity index not greater than 10.
2. Blending: No blending of materials to meet these requirements will be permitted unless authorized by the Engineer. When blending is permitted, the blended material shall be tested and approved before being spread on the roadway.

D. Type B Stabilization:

1. The type of materials, Commercial or Local, shall be at the Contractor's option.
2. No separate payment for stabilizing materials will be made.
3. Bearing Value determinations will be made by the Limerock Bearing Ratio (LBR) Method. For this project, a minimum LBR of 100 shall be required for any base material selected by the Contractor in Section 2.02.D.1.
4. Under this method, it shall be the Contractor's responsibility that the finished roadbed section meets the bearing value requirements, regardless of the quantity of stabilizing materials necessary to be added. Also under this method, full payment will be made for any areas where the existing sub-grade materials meet the design bearing value requirements without the addition of stabilizing additives, as well as areas where the Contractor may elect to place select high-bearing materials from other sources, within the limits of the stabilizing.
5. After the roadbed grading operations have been substantially completed, the Contractor shall make his own determination as to the quantity (if any) of stabilizing material, of the type selected by him, necessary for

compliance with the bearing value requirements. The Contractor shall notify the Engineer of the approximate quantity to be added, and the spreading and mixing in of such quantity of materials shall meet the approval of the Engineer as to uniformity and effectiveness.

2.03 QUALITY CONTROL (Manufacturer & Supplier product quality control specifics required for project)

- A. Material testing shall be performed as directed in Section 01410, Testing and Testing Laboratory Services.

PART 3 - EXECUTION

3.01 PREPARATION

A. General:

1. Prior to the beginning of stabilizing operations, the area to be stabilized shall have been constructed to an elevation such that upon completion of stabilizing operations the completed stabilized subgrade will conform to the lines, grades and cross sections shown in the plans. Prior to the spreading of any additive stabilizing material, the surface of the roadbed shall be brought to a plane approximately parallel to the plane of the proposed finished surface.
2. The subgrade to be stabilized may be processed in one (1) course, unless the equipment and methods being used do not provide the required uniformity, particle size limitation, compaction and other desired results, in which case, the Engineer will direct that the processing be done in more than one (1) course.

3.02 INSTALLATION

A. Stabilizing Material:

1. When additive stabilizing materials are required, the designated quantity shall be spread uniformly over the area to be stabilized.
2. When materials from an existing base are to be utilized in the stabilizing at a particular location, all of such materials shall be placed and spread prior to the addition of other stabilizing additives.
3. Commercial stabilizing material shall be spread by the use of mechanical material spreaders except that where use of such equipment is not practicable other means of spreading may be used, but only upon written approval of the proposed alternate method.

B. Mixing:

1. The mixing shall be done with rotary tillers, or other equipment meeting the approval of the Engineer. The area to be stabilized shall be thoroughly mixed throughout the entire depth and width of the stabilizing limits.
2. The mixing operations, as specified, will be required regardless of whether the existing soils, or any select soils placed within the limits of the stabilized sections, have the required bearing value without the addition of stabilizing materials.
3. As an exception to the above mixing requirements, where the subgrade is of rock, the Engineer may direct that the mixing operations (and the work of stabilizing) be waived and no payment for stabilization will be made for such sections of the roadway.

C. Maximum Particle Size of Mixed Materials: At the completion of mixing, all particles of material within the limits of the area to be stabilized shall pass a 3-1/2 inch ring. Any particles not meeting this requirement shall be removed from the stabilized area or shall be broken down so as to meet this requirement.

D. Compaction: After the mixing operations have been completed and requirements for bearing value, uniformity and particle size have been satisfied, the stabilized area shall be compacted, in accordance with Paragraph 3.03B, hereinafter. The materials shall be compacted at a moisture content permitting the specified compaction. If the moisture content of the material is improper for attaining the specified density, either water shall be added or the material shall be permitted to dry until the proper moisture content for the specified compaction is reached.

E. Finish Grading: The completed stabilized subgrade shall be shaped to conform with the finished lines, grades and cross-section indicated in the Drawings. The subgrade shall be checked by the use of elevation stakes, or other means approved by the Engineer.

F. Requirements for Condition of Completed Sub grade:

1. After the stabilizing and compacting operations have been completed, the subgrade shall be firm and substantially unyielding, to the extent that it will support construction equipment and will have the bearing value required by the Drawings.
2. All soft and yielding material, and any other portions of the subgrade which will not compact readily, shall be removed and replaced with suitable material and the whole subgrade brought to line and grade, with proper allowance for subsequent compaction.

G. Maintenance of Completed Subgrade: After the subgrade has been completed as specified above, the Contractor shall maintain it free from ruts, depressions and

any damage resulting from the hauling or handling of materials, equipment, tools, etc. It shall be the Contractor's responsibility to maintain the required density until the subsequent base or pavement is in place. Such responsibility shall include any repairs, replacement, etc. of curb and gutter, sidewalk, etc. which might become necessary in order to recompact the subgrade in the event of undrained water or other damage occurring to the previously compacted subgrade. Any such work required for recompaction shall be at the Contractor's expense. Ditches and drains shall be constructed and maintained along the completed subgrade section.

3.03 INSPECTION AND TESTING (FIELD QUALITY CONTROL)

A. Bearing Value Requirements:

1. General: Bearing value samples will be obtained and tested by the Testing Laboratory at completion of satisfactory mixing of the stabilized area. For any area where the bearing value obtained is deficient from the value indicated in the Drawings, in excess of the tolerances established herein, additional stabilizing material shall be spread and mixed in accordance with Paragraphs 3.02A.3, 3.02B.1 and 3.02B.2, herein. This reprocessing shall be done for the full width of the roadway being stabilized and longitudinally for a distance of 50 feet beyond the limits of the area in which the bearing value is deficient.
2. Tolerances In Bearing Value Requirements: The following undertolerances from the specified bearing value will be allowed as based on tests performed on samples obtained after mixing operations have been completed:

Specified Bearing Value	Undertolerances
Lime Bedrock Ratio 40	5.0

- B. Density Requirements - General: Within the entire limits of the width and depth of the areas to be stabilized, the minimum density acceptable at any location will be 98 percent (98%) of the maximum density as determined by AASHTO T-180, Test Method D: Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54 Kg (10 lb) Rammer and a 457 mm (18 in) Drop.
- C. Testing Frequency: Tests for Bearing Values and Density will be taken at intervals not to exceed 500 feet on center. Test shall be taken alternating between left, right, and center to insure a uniform sample of the product.

END OF SECTION

SECTION 02 41 13

DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. This Section includes furnishing all labor, materials, equipment and incidentals required for demolition of various existing features as shown on the Drawings and specified herein.
2. This Section provides for the complete or partial removal and disposal of specified existing structures, foundations, slabs, piping, mechanical equipment, electrical systems, and miscellaneous appurtenances encountered during demolition operations.
3. The Contractor shall be responsible for:
 - a. Removal and disposal of list items required, e.g., structures, piping, and equipment as designated on the Drawings.
 - b. Termination of electric facilities in accordance with local codes and the NEC.
 - c. Termination and plugging of potable water piping.
 - d. Final grading and site restoration.
4. The Contractor shall examine the various drawings regarding the proposed site, visit the proposed site and determine the extent of the work, the extent of work affected therein and all conditions under which he is required to perform the various operations.

1.02 PERMITS AND NOTICES

- A. **Permits and Licenses:** Contractor shall obtain all necessary permits and licenses for performing the demolition work and shall furnish a copy of same to the Engineer prior to commencing the work. The Contractor shall comply with the requirements of the permits.
- B. **Notices:** Contractor shall issue written notices of planned demolition to companies or local authorities owning utility conduit, wires or pipes running to or through the project site. Copies of said notices shall be furnished to the Engineer.

- C. Utility Services: Contractor shall notify in writing utility companies or local authorities furnishing gas, water, electrical, telephone or sewer service to remove any equipment owned by them in structures to be demolished and to remove, disconnect, cap or plug their services to facilitate demolition. Copies of notices shall be furnished to the Engineer.

1.03 CONDITIONS OF STRUCTURES

- A. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner insofar as practicable. However, variation among the structures may occur prior to the start of demolition work.

1.04 RULES AND REGULATIONS

- A. The Standard Building Code shall control the demolition, modification or alteration of the existing buildings or structures.
- B. No blasting shall be done on site. The Contractor shall not bring or store any explosives on site.
- C. Disposal of wastewater contents, disinfection and disposal of demolished plant components shall be in accordance with FDEP rules and regulations.
- D. Comply with the current provisions of the following Codes and Standards:
 - 1. ASTM - American Society for Testing and Materials.
 - 2. Standard Specifications B Agency Specified
 - 3. Uniform Building Code

1.05 DISPOSAL OF MATERIAL

- A. Salvageable material shall become the property of the Owner, if the Owner so requests. The Contractor shall dismantle all materials to such a size that it can be readily handled, and deliver any of this salvageable material requested by the Owner to a storage area designated by the Owner.
- B. Delivery and Storage: Do not deliver to the job site nor store thereon demolition equipment and materials prior to receiving written notice to proceed. Confine storage to areas approved by the Owner.
- C. Disposal: Legally dispose of off site products of demolition during or at end of each day's work. Contractor shall pay all disposal costs associated with the project
- D. The following materials are examples of the type that the Owner desires to keep:

1. Pipes and valves greater than 6 inches in diameter (exclusive of buried items).
 2. All machinery and equipment.
 3. All electric panels.
 4. Scrap aluminum or other valuable recyclable metals.
- E. All components are formally in contact with sewage is to be washed by the Contractor with a solution consisting hypochlorite and 50% water. The washwater is to be disposed of into the onsite sanitary system by the Contractor.
- F. Any materials that the Owner rejects shall become the Contractor's property and must be removed from the site.
- G. Waste Concrete and masonry shall be hauled to a legal disposal site by the Contractor.
- H. All other waste metal, wood and other material shall be hauled to a waste disposal site by the Contractor.
- I. The storage of or sale of removed items on the site shall not be allowed.
- J. The Contractor shall dispose of sludge, and grit at the NAU approved location.

1.06 SUBMITTALS

- A. The Contractor shall submit to the Engineers for approval, the proposed demolition and removal plan for the structures and modifications as specified herein prior to the start of work. The Contractor shall include in the schedule the coordination of shutoff, capping and continuation of utility service as required. The demolition and removal plan shall include as a minimum, the following:
1. A detailed sequence of demolition and removal work to ensure the uninterrupted progress of the WWTF operations and the expeditious completion of the work.
 2. Written evidence of approval by the Owner's lead operator of the work plan.
 3. Sequencing and coordination of the work with inspections and subsequent repairs.

- B. Before commencing work, all modifications necessary to bypass the structure to be demolished shall be completed. Contractor shall coordinate with the Owner's personnel to determine the locations of the relevant valves and fittings.

1.07 TRAFFIC AND ACCESS

- A. The Contractor shall conduct demolition and modification operations, and the removal of equipment and debris to ensure minimum interference with roads, streets and walks, both on-site and off-site, and to ensure minimum interference with occupied or used facilities.
- B. The Contractor shall at all time maintain safe and convenient access to the existing site.
- C. Do not close or obstruct streets or walks without permission from the Owner and Engineer. Provide alternate traffic routes around closed or obstructed access ways.
- D. Special attention is directed towards maintaining safe and convenient access to the existing facilities remaining in service by plant personnel and plant associated vehicles. Relocation of the Contractor's materials or equipment due to uncoordinated interruption will be at the Contractor's expense.

1.08 EXISTING UTILITIES

- A. The Contractor shall cooperate with the Owner and utility companies to shut off utilities serving structures of the existing facilities as required by demolition operations.
- B. The Contractor shall be solely responsible for making all necessary arrangements and for performing any necessary work involved in connection with the discontinuance or interruption of all public and private utilities or services under the jurisdiction of the County or utility companies.

1.09 POLLUTION CONTROL

- A. The Contractor shall use water sprinkling, temporary enclosures, and/or other suitable methods as necessary to limit the amount of dust rising and scattering in the air to the lowest level practical. The Contractor shall comply with the governing regulations governing such nuisances.
- B. The Contractor shall clean up all dust, dirt and debris caused by demolition operations. The Contractor shall return all plant and adjacent areas to conditions existing prior to the start of work.

1.07 PROTECTION:

A. Protection of Existing Site Improvements

1. References: Verify and maintain benchmarks, monuments and other reference points.
2. Replace if disturbed or destroyed.
3. Protection: Protect existing improvements noted to remain within designated limit(s) of work. Supply shoring, bracing, reinforcing and barricades as required.
4. Utilities: Keep in operation existing utility circuits and piping to remain except at the direction of the Owner.
5. Repair: If damage to site improvements to remain occurs during the course of the work, restore to the satisfaction of the Owner at no additional cost.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 SEQUENCE OF WORK

- A. The sequence of demolition and renovation of existing facilities shall proceed in accordance with the approved demolition and removal plan specified in Section 01 12 16 Sequence of Construction.

3.02 REMOVAL OF EXISTING PROCESS EQUIPMENT, PIPING AND APPURTENANCES

- A. Existing equipment, non-buried valving and piping, and appurtenances shall be removed or abandoned in-place as shown or indicated on the Drawings, and as specified herein.
- B. All equipment, piping and appurtenances shall be cleaned, flushed and drained. Equipment to be retained by the Owner as specified in Paragraph 1.05, above, shall be dismantled sufficiently to permit thorough cleaning and draining. All valves shall be left open. All abandoned piping shall be capped and sleeves and openings remaining after removal of the existing equipment, piping, and appurtenances shall be plugged and sealed.

3.03 ELECTRICAL REMOVALS

- A. Electrical removals shall consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panelboards, lighting fixtures, and miscellaneous electrical equipment all as shown, specified, or required to perform the Work.

All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to keep the integrity of the grounding systems.

3.04 ALTERNATIONS AND CLOSURES

- A. Alterations shall conform to the Contract Documents.
- B. Where alterations require cutting or drilling into existing floors, walls, and roofs, the holes shall be repaired in a manner acceptable to the Engineer. Contractor shall repair such openings with the same or matching materials as the existing floor, wall, or roof or as otherwise approved by the Engineer. All repairs shall be smoothly finished, unless otherwise approved by the Engineer.
- C. Openings in existing concrete slabs, ceilings, masonry walls, floors and partitions shall be closed and sealed as shown or otherwise directed by the Engineer. The Work shall be keyed into the existing work in a manner acceptable to the engineer. Reinforcing steel shall be welded to the existing reinforcing. Welding shall conform to AWS D12.1, Reinforcing Steel Welding Code. In general, use the same or matching materials as the existing adjacent surface. The finished closure shall be a smooth, tight, sealed, permanent closure acceptable to the Engineer.

3.05 QUALITY CONTROL

- A. The Contractor shall protect all existing materials and equipment to be salvaged or reused from damage.
- B. The Contractor shall cap or plug all lines to be abandoned. The Contractor shall place covers and label all junction boxes, conduits and wire as abandoned.
- C. The Contractor shall promptly repair any and all damage caused to remaining facilities at no cost to the Owner.
- D. Regulatory Requirements: Demolish existing site improvements as specified herein, in an orderly and careful manner. Comply with all local codes and ordinances.
- E. Equipment: Use equipment specifically designed for the demolition of each type of material.
- F. Labor: Employ workmen skilled in the use of the equipment being utilized for demolition.

3.06 REHABILITATION

- A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.
- B. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4 inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same water tightness as through the wall itself. The grouted casings shall then be water cured.
- C. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.
- D. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.
- E. Where existing piping, supports, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains.
- F. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1-1/2 inches, and concrete within the scored lines removed to a depth of 1-1/2 inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish.

3.07 DISPOSAL

- A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities that shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.
- B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.
- C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.08 CLEANING

- A. During and upon completion of work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.
- B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as requested by the Engineer or directed by governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

END OF SECTION

SECTION 02 50 00

PAVING AND SURFACING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. The Work consists of the application of bituminous material on a previously prepared base and overlay of existing asphalt areas in accordance with these Specifications and in accordance with the lines, grades, dimensions, and notes shown on the Drawings.
2. The Work specified in this section consists of the construction of asphaltic concrete surface course composed of a mixture of aggregates, mineral filler and asphalt cement properly laid upon a prepared base or a newly constructed binder course in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical cross section shown on the Drawings. The Contractor shall furnish Type S-1 asphaltic concrete as indicated on the Drawings.

1.02 QUALITY ASSURANCE

- ###### **A. Laboratory analysis on all materials by a Certified Testing Laboratory shall be complete and the materials accepted by the Engineer prior to placement.**

1.03 SUBMITTALS

A. The following submittals are required on all asphaltic concrete:

1. Aggregate Analysis: One (1) per design per FDOT Standard Specifications.
2. Design Mix: One (1) per type per FDOT Standard Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

- ###### **A. Prime Coat: Unless otherwise indicated, the material used for the prime coat shall be cutback asphalt, Grade RC-70 or EC-250 and shall conform with the requirements specified in AASHTO Designation M-81-75 (1982). Unless otherwise indicated, the use of either RC-70 or RC-250 shall be at the Contractor's option.**

- B. Tack Coat: The material used for the tack coat shall be emulsified asphalt, Grade RS-2 and shall conform to the requirements specified in AASHTO Designation M-140-82.
- C. Type S-1 Asphaltic Concrete: Materials used in the type S-1 asphaltic concrete pavement mix shall conform to the applicable DOT requirements. No construction of this type shall be started until the Contractor has submitted a job mix formula prepared by the approved testing agency and has obtained approval from the Engineer. In general, the mix proportions shall be in the following range by weight:

Material	Percent
Mineral Aggregate*	91 - 95.5
Asphaltic Cement (Bitumen)	9-4.5
Total Mix	100

*Maximum recycle mixture of Aggregate is 25%.

1. The bituminous material shall be asphalt cement, viscosity grade AC-20. The aggregate shall be clean and shall contain no deleterious substances. Coarse or fine aggregate containing any appreciable amount of phosphate shall not be used.
2. For the purpose of proportioning the paving mixture, all material passing the No. 10 sieve and retained on the No. 200 sieve shall be considered as fine aggregate and the material passing the No. 200 sieve shall be considered as mineral filler.
3. Any screenings used in the combination of aggregates shall contain not more than 15 percent of material passing the No. 200 sieve. When two (2) screenings are blended to produce the screening component of the aggregate, the combined total of material passing the No. 200 sieve must not exceed 15 percent. Screenings may be washed to meet these requirements.
4. Mineral filler, if needed, shall consist, in general, of lime rock dust, portland cement, slag dust, hydrated lime, or any other inert mineral matter from sources approved by the Engineer. The mineral filler shall be thoroughly dry and free from lumps consisting of aggregations of fine particles. Ground phosphate will not be allowed as a mineral filler.
5. The laboratory compacted mixture shall have a density of not less than 95 nor more than 98 percent of the calculated theoretical density of a voidless mixture composed of the same materials in like proportions. Samples of the

mixture in use shall be taken as many times daily as is necessary and the mixture shall be maintained uniform throughout the Project.

2.02 EQUIPMENT FOR PRIME AND TACK COATING

- A. The pressure distributor for placing the tack or prime coat shall be equipped with pneumatic tires having sufficient width of rubber in contact with the road surface to avoid breaking the bond of or forming a rut in the surface.
- B. The distance between the centers of openings of the outside nozzles of the spray bar shall be equal to the width of the application required, within an allowable variation of 2 inches.
- C. The outside nozzle at each end of the spray bar shall have an area opening of not less than 25 percent, nor more than 75 percent in excess of the other nozzles which shall have uniform openings.
- D. When the application covers less than the full width, the normal opening of the end nozzle at the junction line may remain the same as those of the interior nozzle.

PART 3 – EXECUTION

3.01 PREPARATION AND PRIMING

- A. Cleaning the Base: Before any bituminous material is applied, remove to the shoulders all loose material, dust, caked clay, and foreign material which might prevent proper bond with existing surface. Take particular care to clean the outer edges of the strip to be treated to insure that tack coat will adhere. Where the prime or tack coat is applied adjacent to curb-and-gutter or valley gutter, such concrete surfaces are to be protected and kept free of bituminous material.

3.02 WEATHER LIMITATIONS

- A. Prime and Tack Coats: No bituminous material shall be applied when the air temperature is less than 50 degrees Fahrenheit (°F) in the shade, or when the weather conditions or the condition of the existing surface is unsuitable. In no case shall bituminous material be applied while rain is falling or when there is water on the surface to be covered.
- B. Asphaltic Concrete Type S-1:
 - 1. The mixture shall be spread only when the surface upon which it is to be laid has been previously prepared, is intact, firm and properly cured, and is dry. Unless otherwise approved by the Engineer, no mixture shall be spread that cannot be finished and compacted during daylight hours.

2. The mixture shall not be spread when the wind is blowing to such an extent that proper and adequate compaction cannot be maintained or when sand, dust, etc. are being deposited on the surface being paved, to the extent that the bond between layers will be diminished.

3.03 APPLICATION OF PRIME COAT

- A. After the base has been finished, the full width of surface shall be swept with a power broom supplemented with hand brooms and mechanical blowers prior to the application of the prime coat. Care shall be taken to remove all loose dust, dirt and objectionable matter. If deemed necessary, the base shall be lightly sprinkled with water immediately in advance of the prime coat. The prime coat shall be applied to the full width of the base.
- B. The temperature of the prime material shall be such as to insure uniform distribution. The material shall be applied with a pressure distributor as specified above. The amount to be applied shall be sufficient to coat the surface thoroughly and uniformly without any excess to form pools or to flow off the base. For limerock base, the rate of application shall not be less than 0.10 gallons per square yard; for shell base, the rate of application shall not be less than 0.15 gallons per square yard.
- C. If the roadway is to be opened for use following the application of the prime material, a light uniform application of clean sand shall be applied and rolled. The sand shall be nonplastic, shall be free from silt and rock particles and shall not contain any sticks, vegetation, grass, roots or organic matter. After the sand covering has been applied, the surface may be opened to traffic.

3.04 APPLICATION OF TACK COAT

- A. In general, a tack coat will be used on primed bases except in areas where the prime has not cured and lost its bonding effect.
- B. No tack coat shall be applied until the primed base or leveling course has been cleaned and is free from sand, dust, or other objectionable material.
- C. The tack coat shall be applied with a pressure distributor as specified above. It shall be heated to a suitable consistency and applied in a thin uniform layer at the rate of between 0.02 gallons and 0.08 gallons per square yard.
- D. The tack coat shall be applied sufficiently in advance of the laying of the wearing surface to permit drying, but shall not be applied so far in advance or over such an area as to lose its adhesiveness as a result of being covered with dust or other foreign material. Suitable precautions shall be taken by the Contractor to protect the surface while the tack coat is drying and until the wearing surface is applied.

3.05 GENERAL CONSTRUCTION REQUIREMENTS HOT BITUMINOUS MIXTURES

- A. This section specifies the general construction requirements for the plant-mixed hot bituminous pavements and bases.
1. The mixture shall be transported in tight vehicles previously cleaned of all foreign material and, if necessary, each load shall be covered. The cover shall be used during cool and cloudy weather and at any time where there is probability of rain. The inside surface of the truck bodies shall be thinly coated with soapy water or an approved emulsion containing not over 5 percent oil, but no excess of either shall be used. Kerosene, gasoline, or similar products shall not be used. After the truck bodies are coated and before any mixture is placed therein, they shall be raised so that all excess liquids will be drained out.
 2. A tack coat will be required on the following surfaces:
 - a. Between successive surface courses.
 - b. Between successive leveling courses.
 - c. Between leveling and surface courses tack coat shall also be applied as specified hereinbefore.
 3. All hot bituminous plant-mixed material other than adjacent to curb and gutter or other true edges, shall be laid by the stringline method, to assure the obtaining of an accurate, uniform alignment of the pavement edge. The temperature of the mixture at the time of spreading shall be within 25°F of the temperature set by the Engineer.
 - a. Any mixture caught in transit by rain may be laid only at the Contractor's risk. Should such mixture prove unsatisfactory, it shall be removed and replaced with satisfactory mixture. In no case shall the mixture be laid while rain is falling or when there is water on the surface to be covered.
 - b. In limited areas where the use of the spreader is impossible or impracticable, the mixture may be spread and finished by hand. Straight-edging and back-patching shall be done after initial compaction has been obtained and while the material is still hot.
 4. Surface course materials upon arrival shall be dumped into the approved mechanical spreader and immediately spread and struck-off to the full width required and to such loose depth for each course that, when the work is completed, the required weight of mixture per square yard, or specified thickness, will be secured.

- a. An excess amount of mixture shall be carried ahead of the screen at all times. Hand raking shall be done behind the machine as required.
 - b. Where a surface course is constructed to a thickness greater than 2 inches, it shall be constructed in approximately equal layers and no layer shall be more than 2 inches in thickness when compacted.
 - c. Before any rolling is started, the surface shall be checked, any irregularities adjusted and all drippings, fat sandy accumulations from the screen and fat spots from any source shall be removed and replaced with satisfactory material. No skill patching shall be done. When a depression is to be corrected while the mixture is hot, the surface shall be well scarified before the addition of fresh mixture.
5. For each paving train in operation, the Contractor shall furnish a separate set of rollers and operators. The rolling shall be done in the following sequence, with the equipment as shown, unless otherwise permitted by the Engineer.
- a. Seal rolling, using tandem steel rollers weighing 5 to 12 tons, and following as close behind the spreaders as possible without pickup, undue displacement or blistering of the material.
 - b. Rolling with self-propelled, pneumatic-tired rollers, following as close behind the seal rolling as the mix will permit. The roller shall cover every portion of the surface with at least five (5) passes.
 - c. Final rolling with the 8- to 12-ton tandem steel roller is to be done after the seal rolling and pneumatic-tired rolling have been completed, but before the pavement temperature has dropped below 140°F.

Areas which are inaccessible to a roller shall be compacted by the use of hand tamps or other satisfactory means.

6. The roller shall not be allowed to deposit gasoline, oil, or grease onto the pavement and any areas damaged by such deposits shall be removed and replaced as directed by the Engineer. While the rolling is in progress, the surface shall be tested continuously and all discrepancies corrected to comply with the surface requirements.
- a. All drippings, fat or lean areas, and defective construction of any description shall be removed and replaced. Depressions which develop before the completion of the rolling shall be remedied by loosening the mixture and adding new mixture to bring the depressions to a true surface. Should any depression remain after the final compaction has been performed, the material around the depression shall be replaced with sufficient new mixture to form a true and even surface. All high

spots, high joints and honeycomb shall be corrected as directed by the Engineer.

- b. Any mixture remaining unbonded after rolling shall be removed and replaced. Any mixture which becomes loose or broken, mixed or coated with dirt or in any way defective, prior to laying the wearing course shall be removed and replaced with fresh mixture which shall be immediately compacted to conform with the surrounding area.
 - c. Areas of defective surface may be repaired by the use of indirect heat. No method of repair involving open flame heaters shall be used.
- 7. After final compaction, the density required for type S-1 asphaltic concrete shall be at least 95 percent of the laboratory compacted density of the paving mixture, per ASTM 02950-81.
 - 8. The final surface course will be required to be checked by the use of a rolling or manual straightedge. As soon as the rolling has been completed and the surface has hardened sufficiently to be walked on, the entire surface shall be checked. The finished surface shall not vary more than 1/4 inch from the template cut to the cross-section of the road nor more than 3/16 inch from the straightedge applied parallel to the center line of pavement. Any surface irregularities exceeding these limits shall be corrected. In areas where a reverse crown is used, the asphalt shall be placed so that the lip of the inlets within the road have no more than 1/8" exposed. A maximum of 1/2" above the rim will be allowed.
 - 9. The finished surface shall be of uniform texture and compaction. The surface shall have no pulled, torn, or loosened portions and shall be free of sand streaks, sand spots or ripples. (These requirements shall also apply to any areas where it is necessary to apply hand work.)
 - 10. Any areas which the surface does not meet above requirements for texture, sand streaks, ripples, pulled or loosened portions, or for uniformity of compaction; or does not meet the straight-edging requirements, shall be corrected.
 - a. Such corrections may be made either by replacing the surface course (to full depth) or by overlaying with the type of asphaltic concrete mixture being placed.
 - b. Within the longitudinal limits where such defective areas occur, such corrections shall be made for the full width of the roadway and for longitudinal distances in both directions beyond such defective areas in accordance with the following:

- (1) If the correction is made by replacing the full thickness, it shall extend to at least 50 feet each side of the defective area.
 - (2) If the Contractor elects to effect the correction by overlaying, the overlay shall consist of at least 100 pounds of mixture per square yard at the defective section, and shall taper uniformly down from the full thickness of such weight to zero thickness at the end of a minimum length of 50 feet each side of the defective area.
 - (3) The transverse thickness at any section shall be such as to provide the design cross section.
 - (4) Sections of newly compacted asphalt concrete which are to be covered by additional courses shall be kept clean until the successive course is laid.
11. Upon completion of the finished pavement, no dumping of any material directly on the pavement will be permitted. When shoulders are constructed after completion of the final surface, blade graders operating adjacent to the pavement during shoulder construction shall have a 2-inch by 8-inch (or larger) board (or other attachment providing essentially the same results) attached to their blades in such manner that it extends below the blade edge, in order to protect the pavement surface from damage by the grader blade. Vehicular traffic shall not be permitted on any pavement which has not set sufficiently to prevent rutting or other distortion.

3.06 TESTING REQUIREMENTS

- A. Field Density Tests are to be located no further than 300 feet apart on center with a minimum of one (1) per roadway or parking/maneuvering area.
- B. Thickness Tests are to be located no further than 500 feet apart on centers with a minimum of one (1) per roadway or parking/maneuvering area.

END OF SECTION

SECTION 02 51 00

CONCRETE SIDEWALK

PART 1 - GENERAL

1.01 GENERAL:

- A. The Work specified in this Section consists of the construction of concrete sidewalk in accordance with these Specifications and in conformity with the lines, grades, dimensions and notes shown on the plans.

1.02 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General, Special and Supplementary Conditions and Divisions 00 and 01 Specification Sections, apply to this section.

PART 2 – PRODUCTS

2.01 CONCRETE:

- A. Concrete shall be Class I Concrete, with a minimum compressive strength of 3,000 psi in accordance with Section 345, Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.02 FORMS:

- A. Forms for this Work shall be made of either wood or metal and shall have a depth equal to the plan dimensions for the depth of concrete being deposited against them. They shall be straight, free from warp or bends, and of sufficient strength when staked, to resist the lateral pressure of the concrete without displacement from lines and grade. Forms shall be cleaned each time they are used and shall be oiled prior to placing the concrete.

2.03 SUBGRADE AND GRADING:

- A. Excavation shall be made to the required depth, and the foundation material upon which the sidewalk is to be set shall be compacted to a firm, even surface, true to grade and cross-Section, and shall be moist at the time that the concrete is placed.

2.04 JOINTS:

- A. Contraction joints may be of the open type or may be sawed. Staking a metal bulkhead in place and depositing the concrete on both sides shall form open type contraction joints. After the concrete has set sufficiently to preserve the width

and shape of the joint, the bulkhead shall be removed. After the sidewalk has been finished over the joint, the slot shall be edged with a tool having a 1/2-inch radius.

If the Contractor elects to saw the contraction joints, a slot approximately 1/8 inch wide and not less than 1-1/2 inches deep shall be cut with a concrete saw after the concrete has set, and within the following periods of time:

Contraction joints shall be constructed at not more than 20-foot intervals, and shall be in place within 12 hours after finishing.

PART 3 – EXECUTION

3.01 PLACING

- A. The concrete shall be placed in the forms to the required depth and shall be vibrated and spaded until mortar entirely covers its surface.

3.02 FINISHING

- A. Screeding: The concrete shall be struck-off by means of a wood screed, used perpendicular to the forms, and floated in order to obtain the required grade and remove surplus water and laitance.
- B. Surface requirements: The concrete shall be given a broom finish. The surface variations shall not be more than 1/4 inch under a ten-foot straightedge, nor more than 1/8 inch on a five-foot transverse Section. The exposed edge of the slab shall be carefully finished with an edging tool having a radius of 1-1/2 inch.

3.03 CURING

- A. The concrete shall be continuously cured for a period of at least 72 hours. Curing shall be commenced after finishing has been completed and as soon as the concrete has hardened sufficiently, to permit application of the curing material without marring the surface.
- B. Wet burlap, white-pigmented curing compound, waterproof paper or polyethylene sheets may be used for the curing of grey concrete only.

3.04 MEASUREMENT AND PAYMENT

- A. There shall be no special measurement or payment for the WORK under this Section. It shall be included in the appropriate lump sum price Bid.

END OF SECTION

SECTION 02 82 20

SEEDING AND SODDING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work specified in this Section consists of establishing a healthy stand of grass, within the areas within 10-feet of building and structural lines or on slopes steeper than 6:1, as indicated on the Contract Drawings, and/or on areas disturbed by the construction activity by furnishing and placing grass sod. Also included are fertilizing, watering and maintenance as required to assure a healthy stand of grass. Damage to sod from work performed in right-of-ways or private property shall result in replacement with like sod by the Contractor.

1.02 SUBMITTALS

- A. A certification of sod quality by the producer shall be delivered to the County 10 days prior to use.

PART 2 - PRODUCTS

2.01 GRASS SOD

- A. Grass sod shall be Floratam Augustine or Argentine Bahia grass and shall be well matted with grass roots. The sod shall be taken in rectangles, preferably 12 inch by 24 inch, shall be a minimum 2 inches in thickness and shall be live, fresh and uninjured at the time of planting.
- B. Sod shall be certified to meet Florida State premium grade specifications, absolutely true varietal type, and free from weeds or other objectional vegetation, fungus, insects, and disease of any kind.
- C. It shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling. The sod shall be planted as soon as possible after being dug and shall be shaded and kept moist until it is planted.

2.02 SEED

- A. Seed shall be for the same grass as that existing in residential, commercial and other landscaped areas. Argentine Bahia seed, common variety, may be used in undeveloped areas.

2.03 FERTILIZER

- A. Commercial fertilizer shall comply with the state fertilizer laws.

- 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 6 percent (6%) nitrogen, 6 percent (6%) phosphorus, and 6 percent (6%) potash. At least 50 percent (50%) of the nitrogen shall be derived from organic sources. At least 50 percent (50%) of the phosphoric acid shall be from normal super phosphate or an equivalent source which will provide a minimum of two (2) units of sulfur. The amount of sulfur shall be indicated on the quantitative analysis card attached to each bag or other container.

2.04 WATER FOR GRASSING

- A. Contractor shall coordinate with the County and obtain the water necessary for the sodding operations. The Contractor shall be responsible for all costs.

PART 3 - EXECUTION

3.01 PREPARATION OF GROUND

- A. The area over which the sod is to be placed shall be scarified or loosened to a depth of 6 inches and then raked smooth and free from debris. Where the soil is sufficiently loose and clean, the County, at his discretion, may authorize the elimination of ground preparation.
- B. The ground over which the seeds are to be sown shall be prepared by disk harrowing and thoroughly pulverizing the soil to a suitable depth. The prepared soil shall be loose and reasonably smooth. It shall be reasonably free of large clods, roots, and other material that will interfere with the work or subsequent mowing and maintenance operations.

3.02 APPLICATION OF FERTILIZER

- A. Before applying fertilizer, the soil pH shall be brought to a range of 6.0 to 7.0.
- B. The fertilizer shall be spread uniformly over the area to be sodded at the rate of 700 pounds per acre, or 16 pounds per 1,000 square feet, by a spreading device capable of uniformly distributing the material at the specified rate. Immediately after spreading, the fertilizer shall be mixed with the soil to a depth of approximately 4 inches.
- C. On steep slopes, where the use of a machine for spreading or mixing is not practicable, the fertilizer shall be spread by hand and raked in and thoroughly mixed with the soil to a depth of approximately 2 inches.

3.03 PLACING SOD

- A. The sod shall be placed on the prepared surface, with edges in close contact and shall be firmly and smoothly embedded by light tamping with appropriate tools.
- B. Where sodding is used in drainage ditches, or on slopes of 4:1 or greater, the setting of the pieces shall be staggered so as to avoid a continuous seam along the line of low. Along the edges of such staggered areas, the offsets of individual strips shall not exceed 6 inches. In order to prevent erosion caused by vertical edges at the outer limits, the outer pieces of sod shall be tamped so as to produce a featheredge effect.
- C. On slopes greater than 2:1, the Contractor shall, if necessary, prevent the sod from sliding by means of wooden pegs driven through the sod blocks into firm earth, at suitable intervals.
- D. Sod which has been cut for more than 72 hours shall not be used unless specifically authorized by the County after his review thereof. Sod which is not planted within 24 hours after cutting shall be stacked in an approved manner and maintained and properly moistened. Any pieces of sod which, after placing, show an appearance of extreme dryness shall be removed and replaced by fresh, uninjured pieces.
- E. Sodding shall not be performed when weather and soil conditions are, in the County's opinion, unsuitable for proper results.
- F. When new sod is layed in the right-of-way adjacent to property that has existing sod/grassing, the new sod to be laid in the right-of-way shall be the same type as the existing sod on the adjacent to property.
- G. Where new sod is layed adjacent to existing sod/grassing, the existing sod shall be trimmed on an even, straight line and adjacent grading shall be such that the finished graded of the new sod matches the existing grade of the existing sod/grassing. An uneven irregular finish at the interface of the new sod and existing sod/grassing will not be permitted. Unacceptable placement of sod at the interface shall be reworked for an even and regular interface, if deemed necessary by the County at no additional cost to the County.

3.04 SEEDING

- A. Seed shall be sowed at the rate of six pounds per 1,000 square feet. Depth of cover over seed shall be 1/4 to 3/8 inch.
- B. After seeding, mulch material shall be applied uniformly over the seeded area approximately two inch thick. The mulch material shall then be cut into the soil by disking or other approved equipment, so as to produce a loose-mulched

thickness of three to four inch. Care shall be exercised that the materials are not cut too deeply into the soil. When green mulch is used, the green mulch shall be incorporated into the soil not later than two days after being cut and no artificial watering of the mulch shall be done before it is applied.

3.05 WATERING

- A. The areas on which the sod is to be placed shall contain sufficient moisture, as determined by the County, for optimum results. After being placed, the sod shall be kept in a moist condition to the full depth of the rooting zone for at least 2 weeks. Thereafter, the Contractor shall apply water as needed until the sod roots and starts to grow for a minimum of 60 days (or until final acceptance, whichever is latest).

3.06 MAINTENANCE

- A. The Contractor shall, at his expense, maintain the sodded areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include repairing of any damaged areas and replacing areas in which the establishment of the grass stand does not appear to be developing satisfactorily.
- B. Replanting or repair necessary due to the Contractor's negligence, carelessness or failure to provide routine maintenance shall be at the Contractor's expense.

END OF SECTION

SECTION 02 82 40

TOPSOIL

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Provide all labor, materials, necessary equipment and services to complete the work, as indicated on the drawings, as specified herein or both.
- B. Including but not necessarily limited to the following:
 - 1. Topsoil Stripping.
 - 2. Topsoil Mixing and Spreading.
- C. There shall be no classification of excavation for measurement of payment regardless of materials encountered.

PART 2 - PRODUCTS

2.01 TOPSOIL

- A. Topsoil shall be obtained from any previously established stockpile on site, to the extent that suitable material is available.
- B. Additional topsoil, if required, shall be obtained by mixing existing on-site sandy fill with imported muck or compost.
- C. Topsoil, whether obtained from stockpile, or mixed as described in "B" above, shall be sandy loam, and shall have the following characteristics:
 - 1. 95% of topsoil shall pass a 2-mm. sieve.
 - 2. Topsoil shall be free of stones 1" in longest dimensions, earth clods, plant parts, and debris.
 - 3. Organic matter content shall be 4% to 12% of total dry weight.
 - 4. pH and nutrient content shall be adjusted as necessary to conform to recommendations made by testing laboratory.
- D. Samples shall be tested by the Contractor. Test shall indicate compliance with the specifications and recommendations as to the type and quantity of soil additives required to bring the nutrient content and pH to satisfactory levels for planting

specified plant material. Tests shall be required at a rate of one per 500 cubic yards of material placed, for the first 5,000 cubic yards of material, and may be reduced at the Engineer discretion thereafter. Sampling shall be done in the presence of the Engineer. The Contractor shall be responsible for the cost of testing.

PART 3 - EXECUTION

3.01 JOB CONDITIONS

- A. Protection: Use all means necessary to protect existing objects and vegetation. In the event of damage, immediately make all repairs, and replacements necessary to the acceptance of the Engineer.

3.02 FILLING AND GRADING:

- A. Topsoil shall be spread in a uniform 2" layer after compaction, over all sodded and pervious areas, and finished to grades shown on the plans, making allowance, where necessary, for sod. Grades shown include 0.2' for thickness of sod in all sodded areas.

END OF SECTION

SECTION 02 83 00

CHAIN-LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work included in this Section consists of furnishing and installing a PVC coated steel chain-link fence, 8 feet high, complete with a motorized slide gate, swing gates, and accessories to be constructed around the areas indicated on the Drawings.

1.02 QUALITY ASSURANCE

- A. Erection Qualifications: The fencing erector must be a firm experienced the erection of fencing and accessories of the types specified. The erector must be approved by the manufacturer(s) of the fencing and gates.
- B. Design Criteria: Comply with the standards of the Chain-link Fence Manufacturer's Institute for PVC-Coated Steel Chain-link Fence Fabric, Federal Specification RR-F-191/1A, unless otherwise shown or specified.
- C. Sole Quality Control: Provide each type of fence and gate as a complete unit produced by a respective, single manufacturer, including necessary erection accessories, fittings fastenings and controls.
- D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
 - 1. ASTM A53, Specifications for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses.
 - 2. ASTM A90, Test Method for Weight of coating on Zinc-Coated (galvanized) Iron or Steel Articles.
 - 3. ASTM A392, Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 - 4. ASTM A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 5. Chain-link Fence Manufacturers Institute, Galvanized Steel Chain-Link Fence Fabric.

6. Federal Specifications, RR-F-191/1F, Fencing and Wire and Post, and Metal (Chain-Link Fence Fabric).

1.03 SUBMITTALS

- A. Shop Drawings: Submit shop drawings in accordance with Section 01340: Shop Drawings, Working Drawings and Samples. Shop Drawings for chain-link fence system including plan layout and details illustrating fence height, location and sizes of posts, rails, braces, gates, footings, hardware list, and erection procedures. Provide installation instructions for:
 1. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
 2. Wiring Diagrams: Power and control wiring, and communication and access control features for gate operator and electro-mechanical lock. Differentiate between manufacturer-installed and field-installed wiring and between components provided by gate operator manufacturer and those provided by others.
 3. Descriptive literature of materials to be provided to determine compliance with the specifications.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials shall be in manufacturer's original packaging with all tags and labels intact and legible.
- B. Handle and store materials in such a manner as to avoid damage.

PART 2 - PRODUCTS

2.01 CHAIN-LINK FENCE MATERIAL

- A. Fabric: The fabric shall be black PVC-coated steel chain-link 72 inches high, No. 6 gauge wire woven in a 2 inch mesh. Bottom selvage shall be barbed, top selvage shall be knuckled. The fabric shall conform to the requirements of ASTM Designation A392. The PVC coating shall be a minimum of 0.015 inches per square foot complying with ASTM F-668 and F-1043. The weight of coating shall be determined as defined in ASTM Designation A90.
- B. PVC-coated wire from which the fabric is woven shall withstand exposure for 1000 hours without failure at a black panel temperature of 145°F (63°C) when tested in accordance with ASTM D 1499. Type D, E, or F apparatus described in

ASTM G 23 or Type BH apparatus described in ASTM G 26 shall be used for the test.

C. The product shall be construed to have failed the test if:

1. The wire fails to withstand the mandrel bend test.
2. Shrinkage of the PVC coating is greater than 1/16 inch per ft. (5.2 mm/m) of wire.
3. There is a significant change in color or gloss of the PVC surface as determined by visual inspection.

D. Gate

1. Fabricate gate perimeter frames of tubular members. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware, and accessories. Provide upright and diagonal bracing rails as required for gates.

Fabricate as follows:

a. Horizontal top and bottom frame members:

2.375 in. OD Schedule 40 pipe weighing 3.65 lbs. per lin. ft.,
2 in. square tubing weighing 4.32 lbs. per lin. ft. (Painted black)

b. For gates over 6 ft. high, or leaf width exceeding 8 ft., interior upright bracing: (Painted black)

1.90 in. OD Schedule 40 pipe weighing 2.72 lbs. per lin. ft., or
1.50 in. square tubing weighing 2.60 lbs. per lin. ft. (Painted black)

c. Interior diagonal bracing:

1.66 in. OD Schedule 40 pipe weighing 2.27 lbs. per lin. ft., or
1.50 in. square tubing weighing 1.90 lbs. per lin. ft. (Painted black)

2. Assemble gate frames by welding or with special malleable or pressed steel fittings and rivets for rigid connections. Use same fabric as for fence, unless otherwise indicated. Install fabric with stretcher bars at vertical edges. Bars may also be used at top and bottom edges. Attach stretchers to gate frame on all sides at not more than 15 inches on center. Attach hardware with rivets or by other means which will provide security against removal or breakage.

3. Install diagonal cross-bracing consisting of 3/8-inch diameter adjustable length truss rods on gates where necessary to ensure frame rigidity without sag or twist.
- E. Posts and Other Appurtenances: All posts and other appurtenances used in the construction of this fence shall be hot dipped galvanized with a minimum of 1.8 ounces per square foot of surface. Pipe sections shall conform to the requirements of ASTM Designation A53.
- F. Sizes of Posts, Rails are identified in Table 02830-A.
- G. Posts, Braces, Rails and Gate Frames - Option: Steel pipe manufactured from steel conforming to ASTM A1011, cold-rolled and coated with a minimum of 3 mils cross link polyurethane acrylic exterior coating. Steel pipe shall be of the same external dimension as round posts for the respective uses with minimum wall thickness as designated in Table 02830-B.
- H. Top Rail: The top rail shall be provided with couplings approximately every 20 feet. Couplings are to be the outside sleeve type, at least 6 inches long.
- I. Concrete: Concrete shall have a minimum compressive strength of 3,000 pounds per square inch (psi) at 28 days.
- J. Hardware: Miscellaneous hardware shall be of steel, malleable iron or ductile iron or UHMW of standard design and conform to the requirements of the Chain-Link Fence Manufacturer's Institute. All metal parts shall be galvanized or plated except ties and clips may be made of aluminum.

2.02 INDUSTRIAL HORIZONTAL SLIDING GATE

- A. The Gate complies with ASTM F 1184 for the following slide-gate types:
 1. Single gate.
 2. Classification: Type II Cantilever Slide, Class 2 with internal roller assemblies.
 3. Cantilever Slide Gate is a Fortress Heavy Duty Cantilever Slide Gate.
- B. Frames and Bracing:
 1. The gate frame shall be fabricated from 6063-T5 aluminum alloy extrusions. The top member shall be a 3" x 5" aluminum structural channel/tube extrusion weighing not less than 3.9 lbs/lf. This is also referred to as a "5" extrusion" or "large primary". This member shall be "keyed" to interlock with the "keyed" track member. If fabricated as a

single horizontal piece, the bottom member shall be a 2" x 5" aluminum structural tube weighing not less than 2.0 lbs/lf. If fabricated in two horizontal pieces, the bottom member shall be a 5" aluminum structural channel weighing not less than 2.65 lbs/lf. The two horizontal pieces or sections shall be spliced in the field).

2. The vertical members shall alternate between 2"x2" and 1"x2" in cross section weighing not less 1.1 lbs/lf and .82 lbs/lf respectively. The spacing for the vertical intermediates shall be no greater than half the height of the gate frame.
 3. The gate frame shall be fabricated in one or multiple sections depending on size requirements/constraints.
 4. The gate frame shall have a separate semi-enclosed "keyed" track, extruded from 6105-T6 aluminum alloy, weighing not less than 2.9 lbs/lf. Track member to be located on only one side of the top primary. When interlocked with the "keyed" top member and welded to it, it forms a composite structure with the top of the gate frame. Welds to be placed alternately along the top and side of the track at 9" centers and will be a minimum of 2" long.
 5. The gate frame is to be supported from the track by two pairs of swivel type, self-aligning, 4-wheeled, sealed lubricant, ball-bearing truck assemblies. The bottom of the support posts shall be equipped with two pairs of 3" rubber guide wheels.
 6. Diagonal "X" bracing of 3/16" minimum diameter stainless steel aircraft cable shall be installed to brace the gate.
 7. Frame Corner Construction shall be welded.
- C. Fabric on Gate: The fabric on the gate shall conform to paragraph "2.01 Chain Link Fence Fabric" requirements above. It shall extend the entire length of the gate which (including the opening and counterbalance) and shall be secured at the ends by standard fence industry tension bars and tied with standard fence industry ties at each vertical member.
- D. Gate Posts: Shall conform to the paragraph "2.02 Industrial Fence Framing" requirements above.
- E. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame a minimum of 12 inches (300 mm as required to attach barbed wire assemblies).

- F. Hardware: Latches permitting operation from both sides of gate, and stops fabricated from galvanized steel with stainless-steel fasteners. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

2.03 GATE OPERATOR

A. Acceptable Manufacturers

1. The system as described herein is based on the 9000 series vehicular slide gate operator systems, manufactured by DoorKing, Inc., Inglewood, California. The vehicular slide gate system specified meets requirements of the specifications and shall be considered as the acceptable Base Bid.
2. Substitutions must meet requirements of Prior Approval, as outlined in the contract documents. Substitutions that meet Prior Approval requirements must be listed as alternates by addendum, and shall be shown separately on the bid forms. Consideration will be based on ability to comply with all aspects of the specifications, the desired functional operation, quality, reliability, design, size, and appearance of the equipment, and the support capabilities of the manufacturer.

B. System Description

1. Slide Gate Operator:
 - a. The slide gate operator shall use a microprocessor based solid-state control board that controls all functions of the slide gate operator. Operator shall be rated for continuous duty for use in residential, commercial and industrial applications.
 - b. Primary reduction system shall employ an adjustable clutch and power transfer shall be provided by single cog belt drive train.
 - c. Operator shall employ magnetic sensing to set open and close limit adjustment. Mechanical type limit switches shall not be allowed.
 - d. Operator shall automatically set both open and close limit adjustments upon power-up and activation in the open direction. Operator shall automatically sense for any gate coasting to insure true limit settings.
 - e. Pulling medium shall provide a positive mechanical connection to the gate system. Friction driven rail type pulling mediums shall not be allowed. Roller chain pulling medium shall be minimum size #41.

- f. A positive dead bolt shall activate only when the gate is forced open, to reduce solenoid lock wear and failure.
- g. Operator shall be capable of being mounted at the front, center or rear of the gate system, shall be designed for either left or right hand mount and shall be designed for pad or post mounting.
- h. Operator frame shall use 12-gauge G90 galvanized steel to avoid rusting and shall be painted charcoal gray.
- i. Operator shall have two 115 VAC convenience outlets available for accessory transformer power and shall have a built-in lockable power disconnect and reset switch.

2. Control Circuit:

- a. Control board shall have connections for optional Gate Tracker board. Gate tracker shall record operator cycles (x100), input errors, loop detector errors, obstruction hits, and power up events. Record shall be time and date stamped.
- b. Control board shall allow a stop or a stop and reverse function (settable) from a safety related input.
- c. Control board shall have two ports for plug in of vehicular loop detectors, (DoorKing, Models 9409 or 9410).
- d. A dry set of relay contacts shall be available for external use, and shall have four programmable functions.
- e. A special input shall allow the gate to be partially opened.
- f. A timer override function shall cause an opening gate to stop and then reverse direction when the reverse loop(s) or reverse input is clear even if the gate has not reached the full open position, to help reduce tailgating.
- g. Control board shall have separate inputs for external contact and non-contact entrapment protection devices.
- h. Functions will be user programmable by DIP-switches located on the control board.

3. Fail-Safe Operation

- a. To prioritize safety over security, operator shall assume a fail-safe mode in the event of a power loss or if an entrapment is sensed (entrapment alarm activated).
- b. Operator shall revert to a fail-safe mode allowing the gate to be pushed open without any special knowledge or use of any special cranks, keys or other devices.

4. Primary Electronic Reverse

- a. The vehicular gate operator shall be equipped with an inherent electronic obstruction sensing system. The electronic sensing system shall automatically cause the gate operator to stop and reverse if an obstruction is sensed during the open or close cycle.
- b. For enhanced safety, the control circuit shall check the obstruction sensing system circuit prior to the start of each cycle of operation. Should the control circuit detect a fault in the obstruction sensing system, the motor shall not be allowed to start.

5. Secondary Entrapment Prevention

- a. Non-contact sensors, or contact sensors, or combination thereof, shall be utilized to prevent persons from becoming entrapped in the gate system.
- b. Warning signs shall be installed in accordance with manufacturer's installation instructions and UL 325 guidelines.

6. A complete operational system shall be provided.

C. Equipment

1. Model 9150 Vehicular Slide Gate Operator
Residential / Commercial / Industrial Applications

- a. 1500 Lb. maximum gate weight; 1300 Lb with Convenience Open option
- b. 45-ft maximum gate length.
- c. 1 HP
 - i. 115 VAC
- d. UL Class of Operation I, II, III, IV.

- e. Single cog belt drive train with adjustable clutch.
- f. Automatic limit / coast magnetic adjustment system.
- g. Solid-state control circuit and motor control.
- h. Gate speed approximately 1-ft / sec.
- i. Partial open limit feature.
- j. Anti-Tailgate feature.
- a. #40 roller chain.
- k. Dimensions: 24.75 inches high, 17.75 inches wide, 16.75 inches deep.

D. Secondary Entrapment Prevention

- 1. Non-contact sensors (photo-cells).
 - a. P/N 8080-010 Infrared thru-beam, 165 foot sensing distance.
 - b. P/N 8080-011 Photo-reflective beam, 30 foot sensing distance.
 - c. P/N 8080-030 Polarized photo-reflective beam, 35 foot sensing distance.
 - d. P/N 8080-031 Infrared thru-beam 65 foot sensing distance.
- 2. Contact sensors
 - a. P/N 8080-015 Single-sided sensitivity with mounting channel.
 - b. P/N 8080-020 Three-sided sensitivity with mounting channel.
 - c. P/N 8080-021 Sensor designed to mount on 2 inch round post.
 - d. P/N 8080-022 Sensor designed to mount on 2 inch square post.
- 3. Vehicle Loop Detectors
 - a. P/N 9410-010 Single channel detector.
 - b. P/N 9409-010 Two channel detector.

E. Options

1. Chain tray kit (P/N 2601-270) available in 10-ft sections.
2. Red/Green traffic signal (P/N 1603-208).
3. The traffic signal provides a visual indication to drivers when it is safe to proceed through the gate system.
4. Environmental Control Heater Kit (P/N 1601-154)
5. Nickel plated drive chain (P/N 2600-444).
6. Post Mount Base Plate:
 - a. 9150 Operator use P/N 2600-495
7. Gate operator 3-button (open-close-stop) control stations
 - a. Interior control station P/N 1200-007.
 - b. Exterior control station P/N 1200-006.
8. Gate Tracker Data
 - a. P/N 2351-010 Gate Tracker control board.
9. Convenience open (battery backup) drive system.
10. A complete operational system shall be provided.

PART 3 - EXECUTION

3.01 ARRANGEMENT

- A. Posts: Post shall be uniformly spaced, not to exceed 10 feet on centers. Intermediate posts shall have waterproof tops which have integrally cast openings through which the top rails shall pass. Terminal posts shall consist of end, corner and pull posts.
- B. Braces: Braces shall be provided at each gate, corner, pull and end post.
- C. Top Rails: The top rails shall pass through the line post tops and form a continuous brace from end to end of each stretch of fence. The top rail shall be securely fastened to the terminal posts by heavy pressed steel brace bands and malleable end connections.

- D. Bottom Tension Wire: The bottom tension wire shall be No. 7 gauge aluminum coated spring coil and crimped wire. Minimum weight of aluminum coating shall be 0.40 ounces per square foot of wire surface. The tension wire shall be stretched taut between terminal posts and securely fastened to each intermediate post 6 inches above the finish grade line. Tension wire shall be attached to the fence fabric with aluminum hog rings every 24 inches.
- E. Stretcher Bars: Stretcher bars shall be no less than 3/16 inch by 3/4 inch in cross section and shall have a minimum length 2 inches shorter than the fabric height. Stretcher bars shall be used for attaching the fabric to all terminal posts by threading through the fabric and being attached to the posts with 11 gauge tension bands, or other positive mechanical means, spaced at 12 inch centers. One (1) stretcher bar shall be provided for each gate and end post and two (2) of each corner and pull post.
- F. Ties and Clips: Fabric shall be fastened to all intermediate posts with 9 gauge tie wires, spacing not to exceed 12 inches apart. Fabric shall be tied to top rail with 9 gauge tie wires, spacing not to exceed 14 inches on centers.
- G. Sliding Gates: Single leaf and double leaf gates shall be fabricated with the same material as the fencing and have a minimum 12' clear opening. The gates shall be positioned as shown on the Drawngs. Gates shall be single or double cantilevered design with a chain drive operated by a ½ HP gear motor mounted in a weatherproof housing adjacent to the gate. The gates shall have double UHMW guides and v-notch UHMW support wheels on steel bars.

3.02 INSTALLATION

- A. Post Setting: Line posts shall be set in holes 12 inches in diameter, 38 inches deep with 36 inch post embedment. Terminal posts shall be set in holes 15 inches diameter, 38 inches deep with 36 inch post embedment. After the post has been set and plumbed, the hole shall be filled with concrete. The exposed surface of the concrete shall be crowned to shed water.
- B. Terminal and Gate Posts: Terminal and gate posts shall be set as specified above and shall be braced to the nearest post with a galvanized horizontal brace used as a compression member and galvanized 3/8 inch steel truss rod and truss tighten used as a tension member.
- C. Fabric: Fabric shall not be stretched until concrete footings have cured a minimum of three days. Chain-link fabric shall be placed on the side designated by the Engineer and shall be stretched taut approximately 2 inches above finish grade and securely fastened to all posts. Rolls of wire fabric shall be joined by weaving a single strand into the ends of the rolls to form a continuous mesh.

- D. Gates shall be shop fabricated and delivered to the site intact. The slide gate motor/drive assembly shall be shop fabricated and assembled on-site. A concrete foundation shall be constructed for the motor assembly.

TABLE 02 83 00-A

DIMENSIONS OF POSTS, RAILS AND GATE FRAMES

<u>Designation</u>	<u>Nominal Diameter (Inches)</u>	<u>Outside Diameter (Inches)</u>	<u>Thickness (Inches)</u>	<u>Pounds Per Foot Plain Ends</u>
End, corner and pull posts	2.50	2.875	0.203	5.79
Gate posts (one (1) leaf width over 18 feet)	8.00	8.625	0.322	28.55
Gate posts (one (1) leaf width 13 feet to 18 feet)	6.00	6.625	0.280	18.97
Gate posts (one (1) leaf width 6 feet to 13 feet)	3.50	4.000	0.226	9.11
Gate posts (one (1) leaf width 6 feet or less)	2.50	2.875	0.203	5.79
Intermediate posts	2.00	2.375	0.154	3.65
Braces	1.25	1.660	0.140	2.27
Top Rails	1.25	1.660	0.140	2.27

TABLE 02 83 00-B

STEEL PIPE MINIMAL
WALL THICKNESS

<u>Outside Dimension (Inches)</u>	<u>Wall Thickness (Inches)</u>
1.66	0.111
1.90	0.120
2.375	0.130
2.875	0.160

END OF SECTION

SECTION 02 90 00

LANDSCAPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall furnish all labor, materials, equipment and incidentals required to complete the installation of all planting and other items necessary to complete the work as shown or implied by the Drawings or in the Specifications. The work shall also include the maintenance of all plants and planting areas until the end of the specified maintenance period and the fulfillment of all guarantee provisions as herein specified.
- B. Vehicular and pedestrian traffic control and safety for public and employees shall be the complete responsibility of the Contractor.
- C. The Contractor shall be responsible for cooperation with other trades and professionals on site to assure construction in a timely and professional manner. Coordination of various subcontractors shall be the responsibility of the Contractor unless stated otherwise.

PART 2 - PRODUCTS

2.01 TREES, SHRUBS AND GROUNDCOVERS

- A. All plant material shall be true to botanical, common, and variety name. Botanical name shall have precedence over common name. If a conflict should occur, the County shall make the final determination.
- B. Plant material shall be provided in the species, size, and quantities indicated on the drawings. In the event of a variation between the plant list and the actual number of plants shown on the drawings, the drawings shall control. All sizes specified are minimum dimensions. Plant material shall meet each individual dimension. If the Contractor wishes to exceed the specified tree size in any or all dimensions, he/she must first get approval from the County.
- C. Plant material shall have a habit of growth that is normal for the species and shall be sound, healthy, vigorous and free from insects, pests, eggs or larvae, diseases and injuries. Trees shall be heavily branched and leafed. Trees shall be symmetrically and uniformly branched on all sides (within the character of the species), and free of fresh pruning cuts and planting scars or shipping damage. Multiple trunk trees shall have several main trunks well balanced around an imaginary central axis, to produce a vase shaped branching structure. Standard trees shall have a single straight trunk and well-developed main leader.

Branching angles shall not be less than 30 degrees. Branching shall be even and uniform, with no gaps. Foliage will be full unless characteristic of the tree at the time of planting. Foliage will be flush and green with no chlorosis.

- D. All trees shall be nursery or container grown from the Central Florida area. Any trees from outside the Central Florida area must have prior approval from the County. No field harvested material will be accepted.
- E. All trees shall be Florida No. 1 as outlined under the Grades and Standards for Nursery Plants, Parts I and II (GSPN), Florida Department of Agriculture and Consumer Services and American Standard for Nursery Stock, ANSI (American National Standards Institute, Inc.) 260.1-1986 as approved by the American Association of Nurserymen. If the species specified is not covered specifically in the GSPN or ANSI, it shall conform with the standards and designations in general acceptance by Florida nurseries for type and species. Trees of a grade less than that specified will not be accepted.
- F. All measurements shall be measured when branches are in their normal position. Height and spread dimensions specified refer to main body of tree and not extreme branch, tip to tip. Measurements, as specified, are the measurements after pruning where pruning is required. The caliper of trees shall be taken approximately 4' from grade: Diameter at Breast Height (DBH).
- G. Trees which have been headed back or topped to conform to the size specified will not be acceptable. Trees larger than specified may be used, if approved by the County, however, the use of such plants shall not increase the contract price.
- H. Movement of the trees shall comply with the regulations of all applicable federal, state and local regulations, and all required inspection certificates shall accompany each shipment and shall be filed with the County's representative.
- I. Container-Grown Trees: All container-grown trees shall be well rooted and established in the container in which they are delivered to the site. The trees shall have been in that container sufficiently long for the fibrous roots to hold the soil together when the tree is removed from the container. Root-bound trees will not be accepted. Trees shall not have roots circling the trunk or have a root system too large for the size of container.
- J. Balled and Burlapped (B&B) trees and Wire-Balled and Burlapped (WB&B) Trees: Root balls shall be firmly wrapped with untreated burlap. No synthetic materials shall be used. All ball sizes shall be of a diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant after planting. All balls shall be firm, shall not be broken or cracked, and shall be wrapped and securely tied with heavy biodegradable twine or wire. All trees shall have been root pruned every 6 months. When the tree is root pruned, the tree crown shall be selectively thinned to reduce the volume of the crown.

Care shall be taken to assure that the tree form will not be distorted and will remain typical of the species growth characteristics. All trees shall be hardened off for 2 weeks prior to planting.

- K. The County retains the right to reject trees with cause at any point in the course of the work even after inspection, if he/she deems it necessary, due to a change in the condition of the tree. The County reserves the right to inspect all trees at the growing site. The County reserves the right to reject with cause any materials at any time during the construction process as it becomes necessary.

2.02 OTHER MATERIAL

A. Planting Soil Mix

1. Soil for backfilling planting areas shall be free from subsoil, objectionable weeds, litter, sod, stiff clay, stones, stumps, roots, trash, toxic substances, mortar, cement, or any other deleterious material which may be harmful to plant growth or hinder planting operations. Poorly draining soil shall not be used.
2. Soil amendments shall be added to the soil, as specified and as necessary based on soil tests provided by the Contractor (See #4), to assure optimum plant growth and health. Amendments should be made to adjust pH to within 5.5 to 6.5. Use following tables to determine how much limestone or sulfur is required to adjust the pH.

TABLE I Approximate Ground Limestone or Dolomite Required to Increase Soil pH One Unit		
Soil Texture	Low Organic Matter Content	Moderate Organic Matter Content
	Pounds per 10 sq. ft.	Pounds per 10 sq. ft.
Sand	0.4	0.7
Loamy Sand	0.5	0.8
Sandy Loam	0.6	0.9
Sandy Clay Loam	0.9	1.1

TABLE II Approximate Amount of Wettable Sulfur Required to Decrease Soil pH One Unit		
Soil Texture	Low Organic Matter Content	Moderate Organic Matter Content
	Pounds per 10 sq. ft.	Pounds per 10 sq. ft.
Sand	0.13	0.23
Loamy Sand	0.17	0.27
Sandy Loam	0.20	0.30
Sandy Clay Loam	0.30	0.37

3. If additional soil is required due to unusable or insufficient soil on site, it shall be furnished by the Contractor and shall be a natural, friable soil representative of productive, well-drained soils in the vicinity. It shall be obtained from well-drained areas which have never been stripped before; and shall be free of admixture of subsoil and foreign matter, stones, toxic substances, and any material or substance that may be harmful to plant growth.
 4. Soil testing shall be performed by a qualified soils laboratory, in accordance with "Methods of Soils Analysis-Agronomy #9" as published by the American Society of Agronomy, and shall be performed at the Contractor's expense. These tests shall include but not be limited to soil pH and soil salt levels. The Contractor shall deliver soil test results to the County prior to the beginning of installation.
 5. Planting soil mix for tree wells, if applicable, shall be 50% pulverized existing surface soil, 30% peat and 20% cypress sawdust or shredded cypress bark.
 6. Planting soil mix for trees and palms shall be pulverized existing surface soil unless referred to elsewhere in this document or noted on the plans.
- B. Commercial fertilizer for all trees except palms shall be Woodace or Agrigrow briquettes or approved equivalent shall be used at planting according to manufacturer's recommendations. An organic slow-release fertilizer (16-4-8 or 18-6-12) shall be used after initial installations. Palm fertilizer shall be a 10-5-10 slow-release mix with these elements; 1-3% magnesium, 0.5% manganese, 0.5% iron, and traces of Sulfur, Zinc, Copper and Boron.
- C. Dolomitic limestone shall be a natural limestone, designated for agricultural use, shall contain not less than 85% of total carbonates, and shall be ground so that 50% will pass 100 mesh sieve and 90 percent will pass a 20 mesh sieve. Limestone or sulfur shall be added in the quantity necessary to obtain a pH level within the range of 5.5 - 6.5 unless otherwise noted.

- D. Weed control shall be Ronstar 2G as manufactured by Phodia, Inc., Monmouth Junction, New Jersey 08852 or an approved equivalent.
- E. Antitranspirant shall be an emulsion type, film-forming agent designed to permit transpiration, but retard excessive loss of moisture from plants, such as Dowax by Dow Chemical Co., or Wilt-Pruf by Nursery Speciality Products, Inc., or an approved equivalent. The antitranspirant shall be delivered in the manufacturer's fully identified containers and shall be mixed in accordance with manufacture's instructions.
- F. Boricide shall be Lindane as manufactured by Platt, or an approved equivalent.
- G. Stakes for supporting trees shall be as detailed on the drawings. Wire for fastening trees to stakes shall be No. 12 gauge pliable galvanized steel. Wires in contact with trees shall be encased in two-ply reinforced garden hose which shall form a loose circle around the trunk. Material for wrapping trees trunks, if specified, shall be untreated burlap, in strips 6 to 10 inches wide.
- H. Peat shall consist of 90% organic peat and shall be suitable for horticultural purposes. Peat shall be brown in color and shall be shredded into particles not larger than one-half (½) inch in diameter. Peat shall contain no more than 35% moisture, and the ash content not exceed 10%.
- I. Mulch shall be clean, fresh, and free of foreign materials and seeds. Alternate mulch types, if so identified on the drawings, shall be used as specified.
- J. Water absorbent will be Terrasorb as manufactured by Industrial Services International, Inc., or approved equivalent and will be used according to manufacturer's instructions.
- K. Tree ties shall be Wonder Tree Ties, as manufactured by Alden Enterprises or Adj-a-tye, available through A. M. Leonard, Inc. or approved equivalent.
- L. Fungicide shall be Subdue as manufactured by Ciba Geigy or approved equivalent, and will be used according to manufacturer's instructions.
- M. Superthrive, as manufactured by Vitamin Institute, or approved equivalent, used according to manufacturer's instructions.
- N. Substitutions:

Where it is indicated that the Contractor may furnish or use a substitute that is equivalent to the material or equipment specified and if the Contractor is to furnish or use a proposed substitute, he/she shall, after the award of the contract, make written application to the County for acceptance of such a substitute. The

substituted product or method shall be equivalent or superior in all respects to the specified product or method, shall perform identically the duties imposed by the general design, shall be compatible with all other elements of the job, and shall be sufficient to complete the job. The substitution shall not add cost to the contract. Should it be necessary to accept a substitute of a quality less than specified, the unit price shall be used to adjust the contract price downward accordingly. No substitution shall be ordered or installed without the written permission of the County.

PART 3 - EXECUTION

3.01 DELIVERY

- A. The Contractor shall notify the County of delivery schedule in advance so plant material or other items may be inspected at the job site upon arrival.
- B. The Contractor shall remove unacceptable materials immediately from the job site and dispose of them in a legal and acceptable manner. Any plant with signs of insects, their eggs or larvae, disease, damage or that does not meet the specifications will be rejected and shall be immediately removed from the project site.
- C. The Contractor shall deliver trees with legible identification labels. Representative examples of each species shall be clearly labeled. Previously sealed samples shall be delivered with the seal intact. All trees will be transported to enclosed trucks or will be fully tarped.
- D. The Contractor shall protect trees during delivery to prevent damage to the root ball and branches and desiccation of leaves. Trees shall be protected during transport by tying in the branches and covering all exposed branches. Trees shall be thoroughly protected from chain marks, girdling or other damage, any of which will render a tree unacceptable. All plants shall be handled by the ball or container. All trees shall be sprayed prior to shipping with an antitranspirant such as "Wilt Proof" or approved equivalent, according to manufacturer's recommendations.
- E. Trees indicated on the plans as WB&B and those where size, soil conditions, and distance of transport to the site would warrant, shall be wireballed. Bottom-wired baskets manufactured specifically for use in tree handling shall be used.
- F. Fertilizer shall be delivered to the site in original, unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance to state laws.
- G. Pesticide and herbicide materials shall be delivered to the site in original unopened containers with legible labels.

3.02 STORAGE

- A. Trees not installed on the day of delivery at the site shall be stored and protected as follows:
 - 1. Outside storage shall be shaded and protected from the wind.
 - 2. Balled-and-burlapped and wire balled-and-burlapped plants shall be heeled-in immediately upon delivery if not planted during day of delivery.
 - 3. Trees and palms (including roots and leaves) shall be protected from drying out, and shall be kept moist at all times. Trees must be planted within 24 hours of delivery or be kept in an approved, shaded, irrigated holding area.
 - 4. The Contractor shall assume full responsibility for protection and safekeeping of products stored on the job.

3.03 PREPARATION

- A. The Contractor shall verify through the County's representative that grading operations have been completed and that final grades have been set prior to the installation of trees, shrubs, and groundcovers.
- B. The Contractor shall fine grade all shrub and groundcover areas immediately prior to planting. Plant beds shall be free of noticeable irregularities or unevenness of surface grade.

The Contractor shall stake or flag tree locations and plant bed locations prior to installation to determine potential conflicts with unforeseen obstacles, inconsistencies between plans and field conditions, and any other circumstances which might preclude the planting of trees and shrub beds as indicated on the plans. If such conflicts are encountered, the Contractor shall notify the County prior to proceeding.

- C. Plant beds shall be laid out with smooth bed lines as indicated on the plans.
- D. Plants shall be uniformly spaced at the spacing indicated on the plans. Noticeable gaps in plant beds resulting from poor layout shall be corrected by in-filling with additional plants at the Contractor's expense.
- E. Hedges shall be uniformly spaced and in line, without noticeable gaps or irregularities in layout.
- F. The Contractor shall be responsible for correcting weed outbreaks in plant beds prior to acceptance.

3.04 PLANTING

- A. The Contractor shall verify that final grades have been established prior to beginning planting operations. All unsatisfactory grading shall be reported to the County , and the Contractor shall not proceed with the work until the unsatisfactory conditions have been corrected. When conditions detrimental to plant growth are encountered, such as rubble, fill or adverse drainage conditions, the Contractor shall notify the County for directions.
- B. Should undesirable existing vegetation be present on the site at the time of installation, the Contractor shall prepare the site for planting by use of chemicals, used as recommended by the manufacturer, and/or mechanical means acceptable to the County. Care shall be exercise to avoid any misuse of chemicals which would create detrimental residual conditions. Care must also be used not to alter final grades which have been established or cause damage to previously established turf or planted areas, or trees retained on site. All tree protection barriers around retained trees shall not be disturbed.
- C. Tree location should be established and approved by the County before planting. If there is a discrepancy between plans and utilities or other items on the site that interferes with the planting location of the tree, the Contractor shall bring the situation to the attention of the County for a solution prior to start of any planting operations. If damage should occur to any site feature, utility, plant material or other items due to contractor's work, procedures, equipment or employees, the damage shall be reported to the County immediately. Should repair be required, the Contractor shall bear all costs of the repair, including but not limited to labor, materials, and equipment, and all other fees or penalties associated with the damage, with no cost to the County. At no time should the Contractor attempt to repair the damage without the consent of the County.
- D. Excavate circular pits with vertical sides for all trees. The pits shall be no less than two times greater in diameter than the ball or container or as shown on the plans, whichever is the greater diameter. Bottoms of pits shall be loosened at least six inches deeper than the required depth of excavation.
- E. Plant holes shall be tested for vertical drainage prior to planting. The Contractor shall notify the County's representative prior to planting in areas of inadequate drainage.
- F. Planting soil mixture shall be backfilled and compacted sufficiently in the bottom of the planting hole to support the root ball at the correct height relative to adjacent grade.
- G. Plants shall be placed in the planting holes and oriented to present their best appearance from the most prominent viewpoints.

- H. Planting soil shall then be backfilled and tamped around the rootball to one-half the depth of the root ball. The remainder of the planting soil shall then be backfilled and tamped to bring the soil even with the surrounding grade.
- I. An earthen saucer 4" high shall be formed around all plants for retaining water. The diameter of the saucer shall be equivalent to the diameter of the planting hole. The Contractor shall maintain the saucers until the date of substantial completion. Trees in grass areas shall have saucers removed when sod is installed.
- J. Plants shall be watered-in thoroughly immediately after planting with a hose to eliminate air pockets and to completely wet the root ball and planting soil.
- K. All plant beds shall be top-dressed with the prescribed layer of baled pine straw within 24 hours after planting. Trees in lawn areas shall have grass removed from a 4' radius around the trunk and this circle shall be top-dressed with a layer of baled pine straw.
- L. All plants shall be straight and plumb and root balls shall be at proper grade after planting. Until the end of the guarantee period, plants which have settled or are leaning shall be replanted or straightened by the Contractor as necessary.
- M. Trees shall be planted according to the plans and specifications and shall be set at such level that after settlement they bear the same relation to the finished grade of the surrounding ground as they bore to the grade of the soil from which they were taken. Since a settlement of one inch may be anticipated, the top of the root ball should be planted one inch above finished grade level.
- N. For balled-and-burlapped and wire balled-and-burlapped trees, remove string or wire used to secure burlap to rootball from around the trunk to eliminate the possibility of girdling the tree. No cloth shall be pulled out from under the balls, but should be removed from the sides of the ball. Slits shall be made through the bottom of the material, taking care not to cut any substantial roots. If the ball is cracked or broken before or during the planting process, the plant shall not be planted and shall be removed from the site.
- O. Plants in containers shall be carefully removed from the containers in a manner not to break away from the roots the ball of soil formed by the container. Root balls of container trees shall be carefully scarified or loosened before planting. Scarification shall be performed by loosening the outside 1-2 inches of the rootball by cutting with a knife or shovel edge, being careful not to cut any major roots.
- P. Bottom of plant boxes shall be removed before planting. Sides of the box shall be removed, without damage to the root ball, after positioning the plant and partially backfilling around it.

- Q. Place agriform fertilizer tablets in the planting pit of each tree at the manufacturer's specified rates, 6-8" below the finished grade of the soil, not more than 4" away from the root ball of the tree. Space the tablets evenly around the root ball. Terrasorb or approved equivalent shall be mixed into the planting soil mix according to manufacturer's recommendations. Subdue or approved equivalent shall be applied according to manufacturer's recommendations and will be reapplied every three months. Superthrive, or approved equivalent, will be applied according to manufacturer's recommendations; two weeks after initial planting.
- R. All trees shall be kept in a moistened condition for the duration of the planting period, which shall extend from the time the tree leaves the growing site until the end of the specified maintenance period. The cost of the water shall be incidental to the cost of the tree. Water shall be applied at the rate of 5-7 gallons per inch of caliper per day, per tree. The middle of this range shall be used unless other conditions warrant an adjustment. Such conditions include: very heavy rainfall or lack of rainfall; very sandy, well-drained soils; heavy, poorly drained soils; and compacted poorly drained soils.
- S. Immediately after each plant pit is backfilled, a shallow basin slightly larger than the pit shall be formed with a 4-inch ridge of topsoil to facilitate watering. This soil saucer shall be formed in a circle and tamped around each plant. Where curbing occurs around plant pits, the saucer shall be omitted.
- T. Apply weed control to the surface of all planting pits, beds or planters, beneath the mulch. If specified, add a soil separation mat to the area under the mulch within the tree ring. This shall be done 2-4 weeks after the initial planting, when the watering ring is being smoothed down.
- U. The Contractor shall return all areas impacted by the work or employees, including sodded areas, to as good or better condition than that which previously existed. If the area was previously grassed, it will be repaired, re-sodded, and watered until well-rooted. The sod shall be warranted for one year following final inspection.
- V. Contractor shall provide and properly maintain warning signs, lights, temporary closures, barricades and other security and safeguard measures for the protection of workmen and others on, about or adjacent to the work during working and non-working hours.

3.05 DISPOSAL OF SURPLUS MATERIALS AND DEBRIS

- A. Surplus excavated materials from plant holes shall be disposed of in a manner not to affect the soil levels in the planting beds and may have to be removed from the site by the Contractor at no extra cost to the County. All debris and other

objectionable materials shall be removed from the site and the entire area cleaned up and left in neat condition daily.

3.06 STAKING AND GUYING

- A. Staking and guying of trees shall be done immediately after they are planted. It shall be the Contractor's responsibility to ensure that all trees are plumb and secure after planting. Flags shall denote each guy wire. Guy wires shall be removed after one year unless otherwise directed by the County.
- B. All trees shall be staked so as to allow 1"-2" of movement of the main trunk.
- C. Trees which are less than 1-½" caliper or up to 15 gallon containers shall be staked with two 2-inch-by-2-inch stakes, set at least 24 inches in the ground, 180 degrees apart and extending to the crown of the plant. The plant shall be firmly fastened to the stake with two strands or other approved method.
- D. All trees, with a 1-½" caliper or larger, shall be guyed from at least three points, with double strands of 12-gauge wire. Guy wires shall be anchored to Duckbill Earth Anchors according to manufacturer's recommendations. Tie wires shall be securely fastened to the tree by means of a collar of rubber hose. Guy wires shall be adjusted and kept adjusted by turnbuckles. For trees with a caliper less than 3" a 48 DBL will be used. For trees with a caliper of 3" to 5-½", a 60 DBL will be used. For trees with a caliper of 6" or above, an 88 DBL will be used.

3.07 MULCHING

- A. Mulch tree pits within five (5) days after planting with 2" of baled pine straw.
- B. Cover watering basins evenly with three (3) inches of baled pine straw, unless otherwise noted.
- C. Water thoroughly after applying baled pine straw.
- D. Hose down tree, after planting with fine mist to rinse leaves of dust and grit and, to cool the leaves.
- E. Pine straw shall be maintained in fresh condition and kept continuously in place until end of the maintenance period.

3.08 PRUNING

- A. Pruning shall be done in a manner complying with standard horticultural practices and shall be limited to the minimum necessary to remove injured twigs and branches and to compensate for the loss of roots during transplantings, but never

to exceed one-third (1/3) of the branching structure. Broken or damaged roots shall be cut off smoothly.

- B. All cuts shall be taken back to the next intersecting branch and shall not leave stubs or other projections. Cuts will not be painted. Branch collars will be maintained. Flush cuts are not acceptable.

3.09 DAILY SITE CLEAN-UP

- A. The Contractor shall at all times during the performance of his/her work, keep the entire site free from accumulations of waste materials caused by his/her employees or work. All adjacent surfaces, roads, walks, curbs, etc., shall be kept clean of any products of his/her work. This Contractor shall be held responsible for all damage caused by his/her employees and operations. At the end of each work day, the site shall be thoroughly picked up and equipment properly stored. Safety for employees and public shall be the Contractor's responsibility. All measures necessary to ensure the safety of vehicular and pedestrian traffic and site improvements and plantings shall be taken, and the Contractor takes full responsibility for such items.

3.10 WARRANTY

- A. All new plant material shall be warranted for twelve (12) months from the date of final acceptance and shall be alive and in satisfactory growth for each specific kind of plant, as determined by the County at the end of the warranty period. The County shall be notified by Contractor in writing by certified mail at least 15 days prior to expiration of warranty period(s) and said warranty period shall be continued until such written notification is received and a final walkthrough, with all remedy work, accomplished.

3.11 FINAL INSPECTION AND ACCEPTANCE

- A. The Contractor shall notify the County in writing when the work has been substantially completed in accordance with this contract and request an inspection according to the General and Supplementary Conditions. The County will make the inspection of the work and report findings as to acceptability and completeness. Any work remaining to be done shall be subject to reinspection before final completion.

3.12 REPLACEMENT

- A. At any time during the warranty period, any plant required under this contract that is dead or showing indication of probable nonsurvival or lack of health and vigor; or does not exhibit the characteristics and conditions to still qualify for the minimum grade as originally specified; or will not recover and be within grade by the end of warranty period, as determined by the County or County's

Representative; or adversely impacts the aesthetics of the site, as determined by the County or County's Representative; shall be promptly replaced. Replacement plants shall be warranted as specified for new plants.

- B. Replacement plants necessary during the warranty period shall be the responsibility of the Contractor, except for possible replacements of plants resulting from removal, vandalism, acts of neglect on the part of others or acts of God.
- C. All replacement plants, which are the responsibility of the Contractor, shall be plants of the same kind and size as specified in the Plant List, as shown on the drawings, and in these specifications and shall be planted as specified. The cost of the replacement and all items necessary to replace the tree shall be the responsibility of the Contractor.

END OF SECTION

SECTION 03 11 00
CONCRETE WORK

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. The scope of work under this section includes all materials, equipment and labor, and performing all operations for constructing the concrete work as shown on the drawings, called for herein, or necessary for the proper completion of the work. The work shall be performed in accordance with these specifications and to the lines, notes, and dimensions indicated on the drawings or specified herein. All references to industry standards (ASTM, ANSI, etc.) shall be to the latest revision unless otherwise stated.

1.02 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 01 – General Requirements and Section 01 33 23 – Submittals.

1.03 REFERENCE STANDARDS

- A. Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American Concrete Institute (ACI)
 - a. ACI 301 – Specifications for structural concrete for buildings
 - b. ACI 311 – Recommended Practice for Concrete Inspection
 - c. ACI 318 – Building code requirements for reinforced concrete
 - d. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
 - e. ACI 347 – Formwork for concrete
 - 2. American Plywood Association (APA)
 - a. Material grades and designations as specified
- B. Where reference is made to standards of one of the above, or other originations, the version of the standard in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

- A. The form liner manufacturer's representative shall be on site during the initial installation of the form liner to instruct the Contractor on the proper methods of application and use of the liner. He/she shall be available to answer any questions on the liner that the Engineer may have.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All concrete shall be proportioned, mixed, placed, finished and cured in accordance with the requirements of Standard Specifications of the American Concrete Institute, ACI 301-66, as modified herein, except that concrete for pavement replacement, including sidewalks, driveways and curb and gutter, shall be placed, finished and cured in accordance with ACI 617-58.

2.02 CEMENT

- A. Cement shall be a single brand of Portland Cement conforming to the ASTM Standard Specifications for Portland Cement, Designation C150, for type I cement, type II cement, or type III (high-early-strength) cement.
- B. Air entraining cement shall not be used.
- C. When no Type cement is specified, Type I shall be used.
- D. Type III (high-early-strength) cement may be used only with the written permission of the Engineer, but no additional payment will be made to the Contractor for the use thereof.
- E. In addition to the requirements of the above mentioned specifications, cement to be used in exposed concrete shall exhibit no efflorescence when tested in accordance with the ASTM Standard Methods of Sampling and Testing Brick, Designation C-67, but employing 2 inch x 7 inch x 1/2 inch mortar slabs, comprising a 1:3 mixture by weight of the cement in question and Ottawa Sand, mixed with local tap water to a flow of 100 percent and aged one week before test.
- F. All cement to be used in the work shall be subject to testing to determine whether it conforms to the requirements of these specifications. The methods of testing shall conform to the appropriate specification, but the place, time, frequency, and method of sampling will be determined by the Engineer in accordance with the particular conditions of this project. Cement which is partially set or which is lumpy or caked shall not be used, and the entire contents of the sack of cement or the container of bulk cement which contains damages, partially

set, or lumps of caked cement will be rejected for use.

- G. If required, the Contractor shall furnish sworn certificates of mill tests of cement, in triplicate, at least 7 days before the cement will be used. NAU reserves the right to make such independent tests as he may deem necessary at any time.

2.03 AGGREGATES

- A. Fine aggregate shall be washed sand, clean, sound, sharp, screened and well-graded with no grain larger than will pass a No. 4 sieve. No less than 15 percent are more than 30 percent by weight shall pass a No. 50 sieve. No fine aggregate shall be used if it contains more than 2 percent of silt or which shows a color darker than Plate 2 when tested according to the ASTM Standard Method of Test for Organic Impurities in Sands for Concrete, Designation C40.
- B. Coarse aggregate shall be washed, hard, tough and durable screened gravel or crushed stone having not more than 5% by weight of deleterious substances and soft fragments. Aggregate shall be well graded from the largest which shall pass a 1 inch mesh to the smallest which shall pass a 3/8 inch mesh and be retained by a 1/4 inch mesh. No coarse aggregate shall be used if it contains more than 1 percent of silt or which shows a color darker than Plate I when tested as above specified for fine aggregate.
- C. Both fine and coarse aggregate shall conform to the requirements of ASTM Standard Specification C33. The Contractor shall submit clearly labeled samples of aggregates to the Engineer when requested.

2.04 ADMIXTURES

- A. Admixtures causing accelerated setting of cement in concrete shall NOT be used.
- B. The particular admixture to be used shall meet with the approval of the Engineer.
- C. Recognized and approved admixtures are:
 - 1. Vinsol Resin: Manufactured by the Hercules Powder Company of Wilmington, Delaware: This product requires preparation on the job by dissolving in a solution of sodium hydroxide according to the manufacturer's directions.
 - 2. Darex AEA: Manufactured by the Dewey and Almy Chemical Company, Cambridge, Mass: This product is furnished in liquid form ready for use.
 - 3. Pozzolith: Manufactured by the Master Builders Company, Cleveland,

Ohio: This product is furnished in Powder form ready for use. The use of pozzolith shall be contingent on its entraining the specified amount of air with not more than one pound of the admixture per bag of cement.

4. Aerocrete: Manufactured by L. Sonneborn Sons, Inc., 80 Eighth Avenue, New York, New York, 10011: This product is furnished in liquid form ready for use.

2.05 WATER

The water for concrete shall be clean, fresh, and free from injurious amounts of oil, acid alkali, organic matter, or other deleterious substances.

2.06 CONCRETE PROPORTIONING

- A. Materials shall be proportioned in accordance with ACI-613.
- B. Air content, determined in accordance with ASTM C173, shall be 5% ($\pm 1\%$) by volume.
- C. SLUMP SHALL BE AS LISTED BELOW:
 1. Class A $2 \frac{1}{2} \pm 1$ inch
 2. Class B 3 ± 1 inch
 3. Class C $3 \frac{1}{2} \pm 1 \frac{1}{2}$ inch
- D. Concrete shall be of plastic consistency such that it can be worked readily into all parts of the forms and around embedded work without segregation of constituent materials or collection of free water on the surface. Cement, fine aggregate, coarse aggregate, and water for concrete shall be measured separately and with accuracy.

2.07 PLANT APPROVAL

The Engineer shall have the right to inspect the plant of the manufacturer and the proportioning and mixing of the concrete. The materials method of proportioning, mixing, and delivering are to be satisfactory and in accordance with the above specifications. The manufacturer shall furnish, from an independent testing laboratory and through the Contractor, appropriate certificates of tests, materials, proportions, mixing and strengths if requested by the engineer.

2.08 MIXING AND DELIVERY

- A. The quantity of concrete to be mixed or delivered in any one batch shall not

exceed the rated capacity of the mixer or agitator as stated on the nameplate for the type of mixer in use.

- B. Attention is directed to the importance of dispatching trucks from the batching plant so that they shall arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting. Concrete shall be discharged into forms within 1½ hours after water was first added to the mix, and shall be mixed at least 5 minutes after all water has been added.

2.09 QUALITY

Concrete for slabs on grade (not tank bottoms) shall have a compressive strength of not less than 3,000 psi at 28 days; concrete for fill shall have compressive strength of not less than 2,500 psi at 28 days; concrete for all other work shall have compressive strength of not less than 4,000 psi at 28 days. Concrete of 4,000 psi strength shall be designated Class "A", 3,000 psi concrete shall be designated Class "B", and 2,500 psi concrete shall be designated Class "C".

2.10 REINFORCING STEEL

- A. Concrete reinforcement in sizes No. 3 (3/8 inch) and larger shall be deformed steel bars of the shapes and sizes indicated on the drawings.
 - 1. Deformations shall conform to ASTM Tentative Specifications for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement, Designation A305.
 - 2. The steel shall be newly rolled stock, substantially free from mill scale, rust, dirt, grease, or other foreign matter. Bars shall be domestic billet steel or rail steel.
 - 3. Billet steel bars shall be intermediate grade conforming to the ASTM Tentative Specifications for Concrete Reinforcement, Designation A615.
 - 4. Rail steel bars, if used, shall conform to ASTM Tentative Specifications for Rail Steel Bars for Concrete Reinforcement, Designation A16.
 - 5. In the case of rail steel bars, the bars shall be re-rolled by an approved mill. If requested by the engineer, the Contractor shall submit at his expense certified copies of tests of rail steel bars furnished. The tests shall be as specified in the appropriate ASTM Specifications above referred to, and shall be made by an approved laboratory. To be accepted for use, the bars shall show an elongation of at least 8 inches as required by the ASTM Specifications, but not less than 10.5 %.
- B. If requested by the engineer, the Contractor shall submit for approval shop

drawing submittals for cutting and bending drawings and schedules for all reinforcement to be furnished by him.

- C. Reinforcement shall be accurately formed to the dimensions indicated on the drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness except for bars larger than 1 inch in which case the bends shall be made around a pin of eight bar diameters. All bars shall be bent cold. Bars shall be shipped to the project site fastened in bundles of the same size and shape, with identification tags, giving size and mark, securely attached thereto.
- D. Before being placed in a position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt, and other coatings, including ice, that reduce or destroy bond. Where there is delay in depositing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when necessary.
 - 1. Reinforcement shall be accurately positioned as indicated on the drawings, and secured against displacement by using annealed iron wire ties or suitable clips at intersections. Bar splices, laps, etc., shall be as called for on the drawings, or if not called for, laps shall be not less than 24 times the nominal diameter of the bar. Wire mesh sheets shall have a side lap of not less than 2 inches and an end lap of not less than 6 inches. Concrete blocks having a minimum bearing area of 2 inches by 2 inches and equal in quality to that specified for the slab shall be used for supporting spacers, or hangers may be used. Wood blocks, stones, brick chips, etc., shall not be used to support reinforcement.
 - 2. Reinforcement which is to be exposed to the atmosphere for a considerable length of time after having been placed shall be painted with a heavy coat of cement grout if required by the Engineer.

2.11 FORMS

- A. Forms shall be securely braced, substantial and unyielding, and of sufficient strength to hold the concrete without bulging between supports, or without other deviation from the neat lines as shown on the plans. Forms shall be mortar-tight and shall be constructed of dressed lumber of uniform thickness, with or without a form liner.
- B. The spacing of joints and wales shall be such as to prevent warp and bulging and to produce true and accurate surfaces. All lumber shall be free from knot holes, loose knots, cracks, splits, warps, or other defects affecting its strength or the appearance of the finished concrete surface. Fiberboard or other artificial lumber, approved by the Engineer, may be used as a lining for forms.

- C. The interior surfaces of forms shall be adequately oiled, greased or soaped, to prevent adhesion of mortar. Form oil for exposed work shall be non-staining. Before placing of concrete, the forms shall be cleaned of all dirt, saw dust, shavings or other debris, and the surfaces shall be dampened.
- D. Special care shall be exercised to secure smooth and tight-fitting forms which can be rigidly held to line and grade and removed without injury to the concrete. All corners in the finished work shall be true, sharp and clean-cut. Alignment of forms and grade of top chamfer strips shall be checked immediately after the placing of concrete in the forms.
- E. Forms shall not be removed until the product of the elapsed number of days after placement and the average daily air temperature at the surface of the concrete equals 100 for walls and vertical surfaces and 500 for slabs.
- F. Shores under beams and slabs shall not be removed until the concrete has attained at least 60 percent of the specified cylinder strength and also sufficient strength to support safely its own weight and the CONSTRUCTION LIVE LOADS upon it. Shores under cantilevers shall remain in place at least 14 days after concrete is placed.

2.12 EMBEDDED ITEMS

- A. All sleeves, inserts, hangers, anchor bolts, dowels, nailing strips, or other embedded items, shall be accurately set, and firmly held in place while the concrete is deposited. Anchors and ties for masonry shall be provided as shown on the drawings or called for in the masonry specifications.
- B. Pipes, conduits and other items embedded in the concrete shall be so placed and held that they do not misplace the reinforcing or weaken the concrete at points of maximum stress or where the concrete section is not sufficient to permit the reduction of area caused by the embedment.

2.13 WATER STOPS

Water stops shall be furnished where shown on the drawings and shall be furnished in the longest lengths possible. They shall be rigidly supported and accurately positioned with the center at the joint interface. All water stops shall be approved 5 inch polyvinyl chloride at the dumb-bell, or ribbed type, and a minimum of 3/16 inch thick. They shall be continuous along the concrete joint. Ends and corners shall be spliced to provide water tightness.

PART 3 - EXECUTION

3.0.1 PLACING CONCRETE

- A. All concrete shall be placed during daylight hours allowing sufficient time for adequately finishing the concrete surfaces during daylight hours unless approved by NAU representative for night time construction. No concrete shall be placed until the forms have been approved by the Engineer and until all the reinforcement is in place and has been inspected and approved by the Engineer. No concrete shall be placed in water, and forms shall be free from water, dirt, debris, or any foreign matter when concrete is placed. Normal weather limitations for placing concrete shall be adhered to and no concrete shall be exposed to the action of water before final setting.
- B. The method and manner of placing concrete shall be such as to avoid the possibility of segregation or separation of the aggregates. If the quality of concrete as it reaches its final position is unsatisfactory, the concrete as placed shall be discontinued or adjusted until the quality of the concrete as placed is satisfactory. Open troughs or chutes shall be of metal or metal-lined. Where steep slopes are required the chutes shall be equipped with baffles or shall be in short lengths that reverse the direction of movement. Where placing operations would involve dropping the concrete freely more than five feet, it shall be deposited through pipes, sheet metal or other approved material. Troughs, chutes or pipes with a combined length of more than 30 feet shall be used only on written authority from the Engineer. All troughs, chutes and pipes shall be kept clean and free from coatings or hardened concrete by being thoroughly flushed with water after each run, or in its final position. Depositing a large quantity at any point and running or working it along the forms shall not be done. Special care shall be taken to fill each part of the forms and to work the coarse aggregate back from the face and to force the concrete under and around the reinforcing bars without displacing them. The concrete consistency as measured by slump shall be as specified above.
- C. Concrete shall be compacted by continuous working with a suitable tool in an acceptable manner and by vibrating. Vibration shall be done by experienced operators under close supervision and the duration shall be held to a minimum necessary to produce thorough compaction without segregation. Where vibrators are not used all thin section work shall be thoroughly worked with a steel slicing rod. All faces shall be well spaded and the mortar flushed to the surface by continuous working with a concrete spading implement.
- D. In all cases where, on account of the obstructions produced by reinforcing metal, shapes or forms, or any other uncontrollable condition, difficulty is encountered in puddling the concrete adjacent to the forms, the mortar content of the mix shall be brought into proper contact with the interior surfaces by vibrating the forms. The vibrations shall be produced by striking the outside surfaces of the forms with wooden mallets or by other means satisfactory to the Engineer.

3.0.2 TEST SPECIMENS

If required by NAU, for each class of concrete, one set of three cylinders shall be made by the Testing Laboratory selected by NAU for each day's placement of concrete but not less than one specimen for each 150 cu. yd. One of these cylinders shall be tested at the age of 7 days, and one at the age of 28 days, to determine the quality of concrete obtained. The costs for performing such tests will be paid for by NAU when the test results are in conformity with these specifications. However, those which show no conformity or a failure will be paid for by the contractor. It shall be the responsibility of the contractor to properly inform the Testing Laboratory as to when concrete will be placed into the forms.

3.0.3 CURING & PROTECTION

- A. All concrete work shall be protected against damage from the elements and defacement of any nature during construction operations.
- B. Water shall not be permitted to rise on concrete within 2 hours after it is placed, nor shall running water be allowed to flow over completed concrete within 4 days after it has been placed.
- C. All concrete, particularly slabs and including finished surfaces, shall be treated immediately after concreting or cement finishing is completed to provide continuous moist curing for at least 7 days, regardless of the adjacent air temperature. Walls and vertical surfaces may be covered with continuously saturated burlap, or kept moist by other approved means. Horizontal surfaces, slabs, etc., shall be ponded to a depth of 1/2 inch wherever practicable, or kept continuously saturated wet by the use of lawn sprinklers, a complete covering of continuously saturated burlap, or by other approved means. Except on surfaces to which additional coatings or materials are to be bonded, the Contractor may, at his option, use an approved membrane curing compound in lieu of water curing of concrete. The compound shall be delivered to the job in the manufacturer's containers and shall be applied in strict accordance with the manufacturer's printed instructions.
- D. Curing compound for exposed surfaces shall be non-staining.
- E. For at least 7 days after having been placed, all concrete shall be so protected that the temperature at the surface will not fall below 50 degrees F.
- F. No manure, salt, or other chemicals shall be used for protection.
- G. The above mentioned 7 day period may be reduced to 3 days in each case if high-early- strength cement is used in the concrete.
- H. Wherever practical, finished slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

- I. When the temperature is below 40 degrees Fahrenheit, or predicted to go below 36 degrees in the next 24 hours, or predicted to go below 32 degrees in the next 72 hours, no concrete shall be poured without the express permission of the Engineer. Permission so granted shall be for the day and location only and must again be requested on subsequent days when temperatures are as stated above. The use of chemicals in the concrete mix to reduce temperature of freezing will not be permitted.

3.0.4 FINISHING

- A. Strike off concrete surfaces to elevations and profiles indicated, and finish with wood or cork float as hereinafter specified, even and true, free from cracks, pockets, or other imperfections. Discontinue as soon as water appears on surface. Finished concrete, except at warped surfaces, shall be such that irregularities shall not exceed 1/4 inch as measured by a 10 foot straight edge.
- B. Following removal of forms, thoroughly wet all surfaces to remain exposed. Fill all honeycombs, tie rod holes and areas damaged in form removal with grout composed of one part Portland cement to two parts sand, with water as required, and rub with abrasive stones to a smooth, uniform surface.
- C. Any work not formed as indicated on drawings or that is out of alignment or level or shows a defective surface shall be corrected in a manner satisfactory to the Engineer.
- D. It is expected that forms, concrete and workmanship shall be such that the quantity of trimming and repair work is kept to a minimum.

3.0.5 BONDING AGENT

Where new concrete is to be placed against existing concrete, the existing concrete surface shall be coated with a bonding agent prior to placing new concrete. Application shall be in strict accordance with manufacturer's recommendations.

END OF SECTION

SECTION 03 21 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work in this Section consists of providing all labor, materials, equipment and incidentals required to install all steel bars, steel wire and wire fabric required for the reinforcement of concrete, as shown on the Contract Drawings, and as specified herein.
- B. Related Work:
 - 1. Division 01: General Requirements
 - 2. Section 03 11 00: Concrete Formwork
 - 3. Section 03 25 00: Concrete Joints and Waterstops
 - 4. Section 03 31 00: Cast-in-Place Concrete

1.02 QUALITY ASSURANCE

- A. Standards: Unless otherwise indicated, all materials, workmanship and practices shall conform to the following standards:
 - 1. American Concrete Institute (ACI)
 - a. ACI 117 - Standard Tolerance for Concrete Construction and Materials.
 - b. ACI 301 - Specifications for Structural Concrete.
 - c. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - d. ACI 350 - Environmental Engineering Concrete Structures.
 - e. ACI 315 - ACI Detailing Manual.
 - 2. American Society for Testing and Materials (ASTM)
 - a. ASTM A82 - Specification for Steel Wire, Plain, for Concrete Reinforcement.

- b. ASTM A184 - Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 - c. ASTM A185 - Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 - d. ASTM A496 - Specification for Steel Wire Deformed, for Concrete Reinforcement.
 - e. ASTM A497 - Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
 - f. ASTM A615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - g. ASTM A767 - Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - h. ASTM A775 - Specification for Epoxy-Coated Reinforcing Steel Bars.
 - i. ASTM A884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
- 3. American Welding Society (AWS)
 - a. AWS D1.4 Structural Welding Code - Reinforcing Steel.
- 4. Concrete Reinforcing Steel Institute (CRSI)
 - a. CRSI Manual of Standard Practices.
- 5. Building Codes
 - a. Florida Building Code.
 - b. Local codes and regulations.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

- 1. Submit mill test certificates identifying chemical and physical analyses for each load of reinforcing steel delivered.

- B. Submit shop drawings for review in accordance with Division 01 – General Requirements and Section 01 33 23 - Shop Drawings, Working Drawings, and Samples. Submit reinforcing bending lists and placing drawings for all reinforcing. Placing drawings shall include wall elevations, plan views, and sections to clearly show the reinforcing placing procedures. Placing drawings shall indicate all openings (mechanical, electrical, equipment), including additional reinforcing at openings and intersecting wall, beam and footing arrangements as indicated on the structural drawings and specified herein. Placing drawings shall be coordinated with the concrete placing schedule. Each bending list and placing drawing submitted shall be complete for each major element of a structure (grade slabs, footings, walls, floor or beams), including all dowels and other bars as required. Furnishing such lists shall not be construed that the list will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing reinforcing steel in accordance with the details shown on the plans and as specified.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Reinforcement shall be shipped to the work with bars of the same size and shape fastened in bundles with metal identification tags with waterproof markings giving size and mark securely wired on. The identification tags shall be labeled with the same designation as shown on the submitted bar lists and shop drawings.
- B. All bars shall be stored off the ground and shall be protected from moisture and be kept free from dirt, oil, or injurious contaminants.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete reinforcement in sizes No. 3 (3/8 inch) and larger shall be deformed steel bars of the same sizes and shapes indicated on the Contract Drawings. The steel shall be newly rolled stock of domestic manufacture, substantially free from mill scale, rust, dirt, grease, or other foreign matter. Bars shall be of intermediate grade, deformed billet steel conforming to ASTM Specification A615, Grade 60, including all supplementary requirements.
- B. Rail-steel bars will not be allowed in the work.
- C. Reinforcement shall be accurately fabricated to the dimensions indicated on the Contract Drawings. Particular care shall be exercised not to have stirrups oversized in order to maintain proper coverage of concrete. Stirrups and tie bars shall be made around a pin having a diameter not less than two (2) times the maximum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than five (5) times the minimum thickness of the bar

except for bars larger than 1 inch, in which case the bends shall be made around a pin of eight (8) bar diameters. All bars shall be bent cold. Bars reduced in section or with kinks or bends not shown on the Contract Drawings will not be accepted.

- D. Wire fabric shall conform to ASTM Specification A185, galvanized for Welded Steel Wire Fabric for Concrete Reinforcement. Welded wire fabric shall be furnished in flat sheets, rolled WWF is not permitted.
- E. Wire tie shall be 16-gauge minimum, zinc coated annealed, conforming to ASTM Specification A82.
- F. Bar supports in beams and slabs exposed to view after for stripping shall be galvanized or plastic coated. Use concrete supports for reinforcing in concrete placed on grade.
- G. Coupler Splice Devices: Tension couplers capable of developing the ultimate strength of the bar as manufactured by Erico Products Inc., Solon, Ohio, or equal and where approved by the Engineer.
- H. Reinforcing Steel Accessories
 - 1. Plastic Protected Bar Supports: CRSI Bar Support Specifications, Class 1 - Maximum Protection.
 - 2. Stainless Steel Protected Bar Supports: CRSI Bar Support Specifications, Class 2 - Moderate Protection.
 - 3. Precast Concrete Block Bar Supports: CRSI Bar Support Specifications, Precast Blocks.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Surface condition, bending, spacing, and tolerances of placement of reinforcement shall comply with the CRSI. The Contractor shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Contract Drawings.
- B. Except as otherwise indicated on the Contract Drawings, the minimum concrete cover of reinforcement shall be as follows:
 - 1. Concrete cast against and permanently exposed to earth: 3-in.
 - 2. Concrete exposed to soil, water, sewage, or weather: 2-in.

3. Concrete not exposed to soil, water, sewage, or weather:
 - a. Slabs (top and bottom cover), walls and joists: 3/4 in.
 - b. Beams and columns (principal reinforcement, ties, spirals, and stirrups) 1-1/2 inch.
- C. Reinforcement which will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.
- D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Contract Drawings or specified, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall comply with AWS D1.4.
- E. Reinforcing steel interfering with the location of other reinforcing steel, conduits or embedded items, may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacement of bars to avoid interference shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.
- F. Securely support and tie reinforcing steel to prevent movement during concrete placement by using zinc coated wire ties of not less than No. 16 gauge or suitable clips at intersections. Secure dowels in place before placing concrete.
- G. Do not press dowels into the concrete after the concrete has been placed.
- H. Flat sheet wire mesh shall be placed as follows. Support and tie mesh to prevent movement during concrete placement. Support welded wire fabric by high chairs or bolster with baseplates, all plastic supports, and concrete blocks. It is not permissible to place the WWF on the subbase and pulling it up or laying the WWF on top of the concrete and walking it into the concrete. Extend fabric to within 2 inches of the edges of the slab and lap splices at least 1-1/2 courses of the fabric and a minimum of 6 inches. Tie laps and splices securely at ends and at least every 24 inches with 16 gauge annealed steel wire.
- I. Reinforcing steel bars shall not be field bent except where shown on the Contract Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold-bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld or otherwise repair as approved by the Engineer. Do not bend reinforcement after it is embedded in concrete unless specifically shown otherwise on the Contract Drawings.

3.02 REINFORCEMENT AROUND OPENINGS

- A. Unless specific additional reinforcement around openings is shown on the Contract Drawings, provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by an opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.03 SPLICING OF REINFORCEMENT

- A. Splices designated as compression splices on the Contract Drawings, unless otherwise noted, shall be 30 bar diameters, but not less than 12-in. The lap splice length for column vertical bars shall be based on the bar size in the column above.
- B. Tension lap splices shall be provided at all laps in compliance with the applicable tables in the ACI 315. Splices in adjacent bars shall be staggered. Class A splices shall be used when 50 percent or less of the bars are splices within the required lap length. Class B splices shall be used at all other locations.
- C. Except as otherwise indicated on the Contract Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Adjacent bars shall not be spliced within the required lap length.
- D. Install wire fabric in as long lengths as practicable. Splices in welded wire fabric (WWF) shall be lapped in accordance with the requirements of ACI 318 but not less than 12-in. The splices fabrics shall be tied together with wire ties spaced not more than 24-in on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.

3.04 ACCESSORIES

- A. The Contractor shall be solely responsible for determining, providing and installing accessories such as chairs, chair bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.
- B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.
- C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid

containing areas). Use of galvanized or plastic tipped metal chairs is permissible in all other locations unless otherwise noted on the Contract Drawings or specified.

- D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

3.05 INSPECTION

- A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given at least 24 hours advance notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished his observations of the reinforcing steel.

END OF SECTION

SECTION 03 25 00

CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Section 03 11 00: Concrete Formwork.
- B. Section 03 21 00: Concrete Reinforcement.
- C. Section 03 31 00: Cast-In-Place Concrete.
- D. Section 03 35 00: Concrete Finishes.
- E. Section 03 60 00: Grout.
- F. Section 05 50 13: Miscellaneous Metals.
- H. Section 07 92 13: Joint Sealant

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with the General Conditions, the Special Conditions, and Division 1, shop drawings and product data for the following:
 - 1. Waterstops: Product data including catalogue cut, technical data, storage requirements, splicing methods and conformity to ASTM standards.
 - 2. Premolded joint fillers: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
 - 3. Bond breaker: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
 - 4. Expansion joint dowels: Product data on the complete assembly including dowels, coatings, lubricants, spacers, sleeves, expansion caps, installation requirements and conformity to ASTM standards.

5. Bonding agents: Product data including catalogue cut, technical data, storage requirements, product life, application requirements and conformity to ASTM standards.

B. Certifications

1. Submit certification that all materials used within the joint system are compatible with each other.

1.04 REFERENCE STANDARDS

A. Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following, as applicable:

1. American Society for Testing and Materials (ASTM)
 - a. ASTM A675 – Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
 - b. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - c. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
 - d. ASTM D1751 – Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).
2. U.S. Army Corps of Engineers (CRD).
 - a. CRD C572 – Specification for Polyvinylchloride Waterstops.
3. Federal Specifications
 - a. FS SS-S-210A – Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

B. Where reference is made to standards of one of the above, or other organizations, the version of the standard in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.

2.02 MATERIALS

A. Waterstops

- 1. Plastic waterstops – Expansion joints; 9-in by 3/8-in ribbed type waterstops with center bulb made by extruding elastomeric plastic compound with virgin polyvinyl chloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. The waterstop shall have an integral fastening system (hog rings or grommets at 12-ft on center). Waterstops shall be Style CR-9380 by Paul Murphy Plastics Co., Roseville, MI; Style 709 by Greenstreak Plastic Products, St. Louis, Mo; Style RB9-38 by Vinylex Corp., Knoxville, TN or equal as approved by the Engineer.
- 2. Plastic waterstops – Non-expansion joints; 6-in by 3/8-in ribbed type waterstops made by extruding elastomeric plastic compound with virgin polyvinyl chloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. The waterstop shall have an integral fastening system. Waterstops shall be Style FR-6380 by Paul Murphy Plastics Co., Roseville, MI; Style 697 by Greenstreak Plastic Products, St. Louis, Mo; Style R6-38 by Vinylex Corp., Knoxville, TN or equal as approved by the Engineer.
- 3. Waterstops shall be stored under tarps to protect from oil, dirt, and sunlight.
- 4. Factory made waterstop fabrications shall be used for all changes of direction, intersections, and transitions. Only straight butt joints may be field spliced. All field butt splices shall be heat fused welded using a Teflon covered thermostatically controlled splicing iron in strict conformance with the waterstop manufacturer's recommendations.

B. Premolded Joint Filler

1. Remolded joint filler – structures. Self-expanding cork, premolded joint filler shall conform to ASTM D1752 Type III. The thickness shall be $\frac{3}{4}$ -in unless otherwise shown on the Drawings.
2. Pre-molded joint filler: Sidewalk and roadway concrete pavements or where filler is specifically noted on the Drawings: Fiber joint filler shall be asphalt impregnated fiber board conforming to ASTM D1751. Thickness shall be $\frac{3}{4}$ -in unless otherwise shown on Drawings (Engineer Coordinate with Designer).

C. Bond Breaker

1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint.
2. Bond breaker for concrete other than where tape is specifically called for shall be either bond breaker tape or a nonstaining type bond prevention coating such as Williams Tilt-up Compound by Williams Distributors Inc.; Silcoseal 77, by SCA Construction Supply Division, Superior Concrete Accessories or equal as approved by the Engineer.

D. Expansion Joint Dowels

1. Dowels shall be smooth steel conforming to ASTM A675, Grade 70. Dowels must be straight and clean, free of loose flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04-in on the diameter of the dowel and extends no more than 0.04-in from the end.
2. Expansion dowel caps shall be No. 87 dowel caps as manufactured by Hack Building Products, Inc., Type F-46 dowel caps as manufactured by the Dayton Sure-Trip and Shore Company or equal as approved by Engineer.

E. Bonding Agent

1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation of Lyndhurst, N.J.; Concreseive Liquid (LPL) by Master Builders of Cleveland, OH or equal as approved by Engineer.
2. Latex bonding agent shall be a non-reemulsifiable acrylic-polymer latex conforming to ASTM C1059 Type II.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops

1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Splices shall be made by welding in accordance with the manufacturer's recommendations, subject to acceptance of the Engineer. Only manufacturer's special approved tools shall be used for welding. The finished splices shall provide a cross-section that is dense and free of porosity.
2. To properly secure waterstops in wall joints before concrete is placed, provide waterstops with an integral fastening system. Tie both edges of the waterstop to reinforcing steel with black annealed steel tie wire as specified for tying reinforcing steel and secure in place so that the waterstop will be perpendicular to the joint and remain in the required position during concrete placement.
3. The spacing of the waterstop ties shall match the spacing of the adjacent reinforcing, but need not to be spaced closer than 12-inch on center.
4. Horizontal waterstops in slabs shall be clamped in position by the bulkhead (unless previously set in concrete) and the edge of the waterstop shall be lifted while placing concrete below the waterstop. Then the waterstop shall be manually forced against and into the placed concrete and covered with fresh concrete, to ensure adequate encasement of the waterstop in concrete.
5. Each piece of the waterstop shall be a maximum practicable length to provide a minimum number of splices.
6. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete.

B. Construction Joints

1. Make construction joints only at locations shown on the Drawings (Engineer Coordinate with Designer) or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor, must be submitted to the Engineer for written approval.
2. Additional or relocation joints should be located where they least impair strength of the member. In general, locate joints within the middle third of

spans of slabs, beams, and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams, or girders and at tops of footings of floor slabs. Do not locate joints between beams, girders, column capitals drop panels, and slabs above them. Do not locate joints between brackets or haunches and walls and columns.

3. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings. When joint sin beams are allowed, provide a shear key and inclined dowels as approved by the Engineer.
4. Provide sealant grooves for joint sealant where indicated on the Drawings (Engineer Coordinate with Designer).
5. At all construction joints and at concrete joints designated on the Drawings to be "roughened," uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 1/4-in with suitable tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least 2 hours before and again shortly before the new concrete is deposited, the joints shall be saturate with water. After glistening water disappears, the joints shall be given a thorough coating of neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8 inch thick, well scrubbed-in by means of stiff bristle brushes whenever possible. New concrete shall be deposited before the neat cement dries.
6. In lieu of the above method for securing bond between new and set concrete, the following optional method may be used. Concrete must be allowed to set a minimum of 28 days. Use a bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations and as specified in Section 03740 (Engineer make sure this section is included) with respect to preparation of surfaces and applications of bonding agent.
7. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.
8. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the Engineer (Engineer coordinate with Designer).

C. Expansion Joints

1. Do not extend through expansion joints, reinforcement or other embedded metal items that are continuously bonded to concrete on both sides of joint.
2. Position premolded joint filler material accurately. Secure the joint filler against displacement during concrete placement and compaction. Place joint filler over the face of the joint, allowing for sealant grooves as detailed on the Drawings. Tape all joint filler splices to prevent intrusion of mortar. Seal expansion joints as shown on the Drawings (Engineer coordinate with Designer).
3. Expansion joints shall be 1-in in thickness unless otherwise noted on the Drawings (Engineer coordinate with Designer).
4. Where indicated on Drawings, install smooth dowels at right angles to expansion joints. Align dowels accurately with finished surface. Rigidly hold in place and support during concrete placement. Unless otherwise shown on the Drawings, apply oil or grease to one end of all dowels through expansion joints. Provide plastic expansion caps on the lubricated ends of expansion dowels.
5. Provide center bulb type waterstops in all wall expansion joints and at other locations shown on the Drawings (Engineer coordinate with Designer).

D. Control Joints

1. Provide sealant grooves, sealants and waterstops at control joints in walls as detailed. Provide waterstops at all wall control joints and at other locations shown on the Drawings.
2. Control joints may be sawed if specifically approved by the Engineer. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during sawcutting.
3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings (Engineer Coordinate with Designer). Where specifically noted on the Drawings, coat the concrete surface with a bond breaker prior to placing new concrete against it. Avoid coating reinforcement or waterstops with bond breaker at these locations.

E. Embedments

1. Ensure that all required embedded items are accurately placed at correct locations and orientations.
2. Support embedded items against displacement during concrete placement. Provide templates for position embedded anchor bolts.
3. Voids in sleeves, inserts, anchors, etc., shall be filled temporarily with readily removable material to prevent the entry of concrete.
4. Ensure that all aluminum embedments are effectively coated or covered to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
5. Unless otherwise shown or approved, conduits and pipes embedded within a slab, wall, or beam (other than those merely passing through) shall satisfy the following:
 - a. Embedment of all items shall be brought to the attention of the Engineer in writing.
 - b. Maximum outside dimension shall be no greater than one-third the overall thickness of slab, wall, or beam.
 - c. Spacing shall be greater than or equal to three diameters or widths on center.
 - d. Size, number, and placement shall not significantly impair the strength of the member.

END OF SECTION

SECTION 03 31 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The Contractor shall furnish all labor and materials required and install cast-in-place concrete complete as shown on the Contract Drawings or removed or damaged by the Contractor and as specified herein.
- B. Related Work:
 - 1. Division 01: General Requirements
 - 2. Section 03 11 00: Concrete Formwork

1.02 QUALITY ASSURANCE

- A. Standards: Unless otherwise indicated, all materials, workmanship and practices shall conform to the requirements of the following standards:
 - 1. American Concrete Institute (ACI)
 - a. ACI 301 - Specifications for Structural Concrete.
 - b. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - c. ACI 305 - Hot Weather Concreting.
 - d. ACI 306 - Cold Weather Concreting.
 - e. ACI 308 - Standard Practice for Curing Concrete.
 - f. ACI 309 - Standard Practice for Consolidation of Concrete.
 - g. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - h. ACI 347 - Guide to Concrete Formwork.
 - i. ACI 350 - Environmental Engineering Concrete Structures.
 - 2. American Society for Testing and Materials (ASTM)

- a. ASTM C31 - Standard Practice Making and Curing Concrete Test Specimens in the Field.
 - b. ASTM C33 - Standard Specification for Concrete Aggregates.
 - c. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - d. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - e. ASTM C94 - Standard Specification for Ready-mix Concrete.
 - f. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - g. ASTM C150 - Standard Specification for Portland Cement.
 - h. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
 - i. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - j. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - k. ASTM C260 - Specification for Air-Entraining Admixtures for Concrete.
 - l. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - m. ASTM C494 - Chemical Admixtures for Concrete.
 - n. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
3. Building Codes
- a. Standard Building Code (SBCCI).
 - b. Local Codes and Regulations.

B. Plant Qualification: Plant equipment and facilities shall meet all requirements of the Check List for Certification of Ready Mixed Concrete Production Facilities of the National Ready Mixed Concrete Association and ASTM C94.

C. Evaluation and Acceptance of Concrete: Evaluation and acceptance of concrete will be in accordance with ACI 318, Chapter 4.

1. Watertightness

All structures to contain wastewater or water shall be watertight and shall be free from any perceptible leakage, as determined by the Engineer.

1.03 SUBMITTALS

A. Materials and Shop Drawings: The following information shall be submitted for approval in accordance with Division 01 – General Requirements and Section 01 33 23 – Submittals. No concrete shall be furnished until submittal has been approved.

1. Plant Qualification: Satisfactory evidence shall be submitted indicating compliance with the specified qualification requirements.

2. Materials: Satisfactory evidence shall be submitted indicating that materials to be used, including cement, aggregates and admixtures meet the specified requirements. Provide catalog data, chemical and mechanical analysis, and conformance with ASTM requirements.

a. Sources of cement, pozzolan and aggregates.

b. Air-entraining admixture.

c. Water reducing admixture.

d. High range water-reducing admixture (plasticizer).

e. Sheet curing material.

f. Liquid curing compound.

3. Design Mix: The design mix to be used shall be prepared by qualified persons and submitted for approval. The design of the mix is the responsibility of the Contractor subject to the limitations of the Specifications. Approval of this submission will be required only as minimum requirements of the Specifications have been met. Such approval will in no way alter the responsibility of the Contractor to furnish

concrete meeting the requirements of the Specifications relative to strength and slump.

4. Ready Mix Concrete: Provide delivery tickets or weighmasters certificate per ASTM C94, including weights of cement and each size aggregate, amount of water in the aggregate, and amount of water added at the plant. Write in the amount of water added on the job.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement

1. Cement for all concrete shall be domestic Portland cement that conforms to the requirements of ASTM Designation C150 Type I, Type II or Type III. All sanitary sewer manholes, wet wells, pumping stations, and structures exposed to wastewater shall be constructed with Type II cement. Type III cement for high early strength concrete shall be used only for special locations and only with the approval of the Engineer. Type I cement may be used for buildings and tremie concrete.
2. Only one (1) brand of cement shall be used in any individual structure unless approved by the Engineer. Cement which has become damaged, partially set, lumpy or caked shall not be used and the entire contents of the sack or container which contains such cement will be rejected. No salvaged or reclaimed cement shall be used.

B. Pozzolan

1. Fly ash shall be Class C or F conforming to the requirements of ASTM C618, including the requirements of Table 1 except the loss of ignition, LOI, shall be limited to 3% maximum. Fly ash shall not exceed 20% of the cementitious content of the mix.

C. Aggregates

1. Coarse aggregates shall be size No. 67 (3/4 inch). Block cell fill shall be size #8, conforming to the requirements of ASTM C33.
2. In addition to requirements of ASTM C33 for structures exposed to wastewater the following shall apply:
 - a. Soft particles: 3.0 percent (3%).

- a. Chert as a soft impurity (defined in Table 3 of ASTM C33): 2.0 percent (2%).
 - b. Total of soft particles and chert as a soft impurity: 5.0 percent (5%).
 - c. Flat and elongated particles (long dimension greater than 5 times short dimension): 15.0 percent (15%).
- D. Water: Clean and free from injurious amounts of deleterious materials.
- E. Air Entraining Admixture: ASTM C260.
- F. Water Reducing and Retarding Admixtures:
 - 1. For concrete without superplasticizer: ASTM C494, Type D, and shall contain no calcium chloride by weight of cement.
 - 2. For concrete with superplasticizer
 - a. ASTM C494, Type F or G. The admixture shall be a second generation type, free of chlorides and alkalis (except for those attributable to water) and composed of a synthesized sulfonated complex polymer. The concrete shall be capable of maintaining its rheoplastic state in excess of two (2) hours if necessary. Superplasticizers admix shall be induced at the batch plant only, job site redosage shall not be permitted without prior approval from the Engineer.
 - b. Approved Materials:
 - (1) Rheobuild 716 as manufactured by Rheobuild 716 as manufactured by Master Builders Technologies or "Kurez-DR", as manufactured by Euclid Chemical Co.
 - (2) Daracem 100 as manufactured by W.R. Grace & Co. Construction Products Division, Pompano Beach, Florida.
 - c. Manufacturer's job site representation: A competent field service representative from the manufacturer of each of the admixtures (superplasticizer) selected for use shall be available at the job site to provide advice and consultation on the use of the admixture materials, including the effect on the concrete in place. The representative shall be available on short call at any time requested by the Owner, Contractor, or concrete producer.

- d. Manufacturer's representative will be responsible to recommend maximum discharge time for superplasticizer and to recommend method and procedure to induce superplasticizer into mixer.
 - e. Manufacturer's representative will be responsible to recommend quantities of admixtures to be used if variations are required because of temperature/humidity, wind, or other environmental considerations.
 - f. Concrete with super plasticizer shall be used for all cast-in place walls of structures.
- G. Curing Compound: ASTM C309, Type 1. The compound shall contain no ingredient which will adversely affect the bond of coatings or toppings. Curing compound shall be approved for use in contact with potable water after 30 days.
 - 1. Curing compound for exposed concrete not to receive special finishes, protective coatings and/or concrete toppings shall be "Super Rez-Seal", as manufactured by Euclid Chemical Co., Cleveland, Ohio or equal.
 - 2. Curing compound for exposed concrete to receive special finishes, protective coatings and/or concrete toppings shall be "Kurez-DR", as manufactured by Euclid Chemical Co., Cleveland, Ohio or equal.
- H. Mortar for Repair of Concrete: 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 (1) part cement to two and one-half (2-1/2) parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for handling and placing.
- I. Burlap Mats: Conform to AASHTO Specification M-182.
- J. Epoxy Bonding Agent: Sikadur 32 Hi Mod, or equal.

2.02 MIXES

- A. General Requirements:
 - 1. Mix Design: Proportioning shall be on the basis of field experience and/or trial mixtures as specified in ACI 318, Section 4.3. Data on consecutive compression tests and standard deviation shall be submitted. Proportioning for small structures may be by the water/cement ratio under special approval by the Engineer. Concrete mix design shall comply with the Standard Building Code requirements.
 - 2. Air Content: Range 3.5 to 6% for Class A and B.

3. Slump: 4 inches plus or minus 1 inch for Class A and B without superplasticizer.

8 inches plus or minus 1 inch for concrete with superplasticizer.

6 inches plus or minus 1 inch for tremie concrete.

4. Water cement ratio = 0.45 (Class A Concrete) without superplasticizer.
= 0.55 (Class B Concrete) without superplasticizer.
= 0.37 Concrete with superplasticizer.

5. Minimum Compressive Strength at 28 days:

- a. Class A, 4,000 psi: Wastewater structures inclusive of mat foundations, footings, tanks, ditches, pumping station, tremie concrete and other structures in contact with treated waters.
- b. Class B, 3,000 psi: Slab on grade, masonry fillcell grout, encasements, thrust blocks, and pipe supports, concrete curbs, fills and sidewalks, etc. not in contact with treated waters.
- c. Slab on grade shall include all slabs 10 inches thick or less and requires Class B 3000 psi concrete. Exception: Sludge Loading Station, 10-inch Slab Drawing S-39 shall be Class A 4000 psi.

B. Production of Concrete:

1. General: Concrete shall be ready mixed and shall be batched, mixed and transported in accordance with ASTM C94, except as otherwise indicated.
2. Air Entraining Admixture: Air entraining admixture shall be charged into the mixture as a solution and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water.
3. Water Reducing and Retarding Admixture: Water reducing and retarding admixture shall be added and measured as recommended by the manufacturer. The addition of the admixture shall be separate from the air entraining admixture. The addition of the admixture shall be completed within one minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Admixtures shall be stored,

handled and batched in accordance with the recommendation of ASTM C94.

- C. Delivery Tickets: In addition to the information required by ASTM C94, delivery tickets shall indicate the cement content and the water/cement ratio.
- D. Temperatures: The temperature of the concrete upon delivery from the truck shall not exceed 95 degrees Fahrenheit (°F), otherwise ice shall be used to reduce the temperature of the concrete as recommended by ACI.
- E. Modifications To The Mix: No modifications to the mix shall be made in the plant or on the job which will decrease the cement content or increase the water-cement ratio beyond that specified. No modifications of any kind shall be made except by a qualified and responsible representative of the concrete producer.
 - 1. Any addition of water must be approved by the Engineer. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket. Addition of water shall follow procedures of ASTM C94 for slump adjustment.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Preparations Before Placing: No concrete shall be placed until the approval of the Engineer has been received. Approval will not be granted until forms are thoroughly clean and reinforcing and all other items required to be set in concrete have been placed and thoroughly secured. The Engineer shall be notified a minimum of 24 hours before concrete is placed.
- B. Conveying:
 - 1. General: Concrete shall be handled from the truck to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients to maintain the quality of the concrete. No concrete shall be placed more than 90 minutes after mixing has begun for that particular batch.
 - 2. Buckets and Hoppers: Buckets and hoppers shall have discharge gates with a clear opening equal to no less than one-third of the maximum interior horizontal area, or five (5) times the maximum aggregate size being used. Side slopes shall be no less than 60 degrees. Controls on gates shall permit opening and closing during the discharge cycle. It is suggested the Contractor provide one (1) standby bucket and hopper for use in case of equipment failure.

3. Runways: Extreme care shall be exercised to avoid displacement of reinforcing during the placing of concrete.
4. Elephant Trunks: Hoppers and elephant trunks shall be used to prevent the free fall of concrete for more than 6 feet.
5. Chutes: Chutes shall be metal or metal lined, and shall have 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 requirements, may be used only if they discharge into a hopper before distribution.
6. Pumping Equipment: Pumping equipment and procedures, if used, shall conform to the recommendations contained in the report of ACI Committee 304 on "Placing Concrete by Pumping Methods", ACI 304.2R. The specified slump shall be measured at the point of discharge. The loss of slump in pumping shall not exceed 1-1/2 inches.
7. Conveying Equipment Construction: Aluminum or aluminum alloy pipe for tremies or pump lines and chutes, except for short lengths at the truck mixer shall not be permitted.
8. Cleaning: Conveying equipment shall be cleaned at the end of each concrete operation.

3.02 APPLICATION

A. Placing:

1. General: Concrete shall be deposited continuously, or in layer of such thickness (not exceeding 2 feet in depth) that no concrete will be deposited on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness.
2. Supported Elements: At least 2 hours shall elapse after depositing concrete in columns or walls before depositing in beams, girders, or slabs supported thereon.
3. Segregation: Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to procedures which will cause segregation.
4. Concrete Under Water: All concrete, except that indicated on the Drawings as Tremie concrete, shall be placed in the dry.

5. Concrete Fill and Tank Bottom Slab: Concrete fill for the tank bottoms, where shown on Drawings, shall be placed within the tolerances described in this Section and as per equipment manufacturer's recommendations

B. Seals and Tremie Concrete:

1. General:

- a. Wherever practicable, all foundation excavations shall be dewatered and the concrete deposited in the dry. Where conditions are encountered which render it impracticable to dewater the foundation before placing concrete, a concrete foundation seal shall be placed. The foundation shall then be dewatered, and the balance of the concrete placed in the dry.
- b. When seal concrete is required to be placed, the satisfactory performance of the seal in providing a watertight excavation for placing structural concrete shall be the responsibility of the Contractor. Seal concrete placed by the Contractor, which subsequently fails to perform properly, shall be repaired as necessary to perform its required function, at the expense of the Contractor.

2. Method of Placing: Concrete deposited under water shall be carefully placed in the space in which it is to remain by means of a tremie, a closed-bottom dump bucket of not less than one cubic yard capacity, or other approved method, and shall not be disturbed after it is deposited. All seal concrete shall be deposited in one (1) continuous pour. No concrete shall be placed in running water. All form work designed to retain concrete under water shall be watertight, and the design of the form work and excavation sheeting shall be by a Professional Engineer, registered in the State of Florida.

3. Use of Tremie: The tremie shall consist of a tube having a minimum inside diameter of 10 inches, and shall be constructed in sections having tight joints. No aluminum parts which have contact with the concrete will be permitted. The discharge end shall be entirely seated at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper the tremie shall be slightly raised (but not out of the concrete at the bottom) until the batch discharges to the bottom of the hopper, after which the flow shall be stopped by lowering the tremie. The means of supporting the tremie shall be such as to permit the free movement of the discharge end over the entire top surface of the work, and shall permit it being lowered rapidly when necessary to choke off or retard the flow. The flow shall preferably be continuous and in no case

shall be interrupted until the work is completed. Special care shall be exercised to maintain still water at the point of deposit.

4. Use of Bottom-dump Bucket: When the concrete is placed by means of a bottom-dump bucket, the bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. The bucket shall then be raised very slowly during the discharge travel; the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture. Aluminum buckets will not be permitted.
5. Time of Beginning Pumping: Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure, and in no case earlier than 72 hours after placement of the concrete.

C. Consolidating Concrete:

1. General: Concrete, with the exception of slabs less than 8 inches thick, shall be consolidated by means of internal vibrators operated by competent workmen.
 - a. Concrete Slabs: Concrete for slabs less than 8 inches shall be consolidated with vibrating screeds; slabs 8-inches to 12-inches thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.
2. Vibrators: Vibrators shall have a minimum head diameter of at least 2 inches, a minimum centrifugal force of 700 and a minimum frequency of 8,000 vibrations per minute.
3. Vibrators for Confined Areas: In confined areas, the specified vibrators shall be supplemented by others having a minimum head diameter of 1-1/2 inches, a minimum centrifugal force of 300 pounds and a minimum frequency of 9,000 vibrations per minute.
4. Spare Vibrator: One (1) spare vibrator for each three (3) in use shall be kept on the site during all concrete placing operations.
5. Use of Vibrators: Vibrators shall be inserted and withdrawn at points approximately 18 inches apart. The duration of each insertion shall be from 5 to 15 seconds. Concrete shall not be transported in the forms by means of vibrators.

D. Protection: Rainwater shall not be allowed to increase the mixing water, nor to damage the surface finish. Concrete shall be protected from construction

overloads. Design loads shall not be applied until the specified strength has been attained.

- E. Construction Joints: Except as otherwise indicated on the Drawings, horizontal construction joints shall be provided at top of foundation members and slabs on grade and at the soffit of supported slabs and beams. Other horizontal and vertical construction joints shall be located as indicated on the Drawings. Joints will not be permitted except in the locations shown, unless recommended by the Contractor and approved by the Engineer.
- F. Bonding: Before depositing new concrete on or against concrete that has set, the surfaces of the set concrete shall be thoroughly cleaned so as to expose the coarse aggregate and be free of laitance, coating, foreign matter and loose particles. Forms shall be retightened. The hardened concrete of joints shall be dampened, but not saturated, and then thoroughly covered with a coat of cement grout of similar proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 1/2 inches thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained its initial set.
- G. Embedded Items: In addition to steel reinforcement, pipes, inserts and other metal objects as shown, specified or ordered shall be built into, set in or attached to the concrete. All necessary precautions shall be taken to prevent these objects from being displaced, broken or deformed. Before concrete is placed, care shall be taken to determine that all embedded parts are firmly and securely fastened in place as indicated. They shall be thoroughly clean and free from paint or other coating, rust, scale, oil, or any foreign matter. No wood shall be embedded in concrete. The concrete shall be packed tightly around pipes and other metal work to prevent leakage and to secure proper adhesion. Drains shall be adequately protected from intrusion of concrete.
- H. Concrete Finishes: Complete concrete surfaces in accordance with the following schedule:
- | | | |
|----|-------------|---|
| 1. | Finish | |
| | Designation | Area Applied |
| | F-1 | Exterior walls below grade not exposed to water. Repair defective concrete, fill depressions deeper than 1/2 inch and fill tie holes. |
| | F-2 | Exterior and interior walls of all structures. Repair defective concrete, remove fins, fill depressions and fill tie holes. |
| | F-3 | Walls of all structures or buildings exposed to public view and the underside of formed floors or slabs that will not be |

finish coated or sealed. In addition to Finish F-2, fill depressions and airholes with mortar. Dampen surfaces and then spread a slurry within 72 hours of removing forms consisting of one part cement and one and one-half parts sand by volume on the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.

- F-4 Walls of all structures and buildings exposed to public view and the underside of formed floors or slabs that will be finish coated in accordance with Section 09 96 00 Painting and Coating. In addition to Finish F-2, surfaces shall be sand blasted and holes patched and depressions and airholes filled with a patching compound consisting of sand, portland cement and a liquid, acrylic-polymer bonding additive. Refer to Section 09 96 00 Painting and Coating, for concrete surface preparation requirements.
- S-1 Slabs and floors not water bearing. Smooth steel trowel finish.
- S-2 Slabs and floors which are water bearings. Slab Surfaces on which mechanical equipment moves. Steel trowel finish free from trowel marks and all irregularities.
- S-3 Slabs and floors of structures or building exposed to view. 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.
- S-4 Slabs and floors at slopes greater than 10 percent. Steel trowel finish without local depressions or high points. Apply a stiff bristle broom finish. Leave broom lines perpendicular to the direction of slope drainage.
- E-1 Exposed edges of slabs, floors and tops of walls. Finish with a 1/4 inch radius edge if a chamfer is not indicated.
- E-2 Tops of walls, beams and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of formed surfaces.

2. General: As soon as forms can safely be removed, all irregular projections shall be chipped off flush with the concrete surfaces. All voids produced

by spacers or any honeycombing shall be pointed up with grout and troweled flush with the concrete surface immediately after removal of forms and water cured to prevent shrinkage. Honeycombing shall be cut out to expose a sound concrete surface prior to pointing. The use of mortar pointing or patching shall be confined to the repair of small defects in relatively green concrete. Where in the opinion of the Engineer substantial repairs are required, the defective concrete shall be cut out to sound concrete and repaired with gunite or the concrete shall be removed and reconstructed as directed.

3. All concrete slabs to be troweled shall receive a floated finish. After floating, all concrete slabs except as otherwise indicated and in areas to receive roofing, insulation, tile or topping shall be troweled and immediately light broom finished. Stair treads shall receive a light broomed finish.
4. Floated Finish: After concrete has been placed. Consolidated, struck off and leveled, it shall not be worked further until water sheen has disappeared and the surface has hardened sufficiently to permit floating, the planeness of the slab shall be checked with a 10 foot straightedge applied at no less than two (2) angles. All high spots shall be cut down and all low spots shall be filled to produce a surface having a Class B Tolerance throughout. The slab shall then be refloated to a uniform sandy texture.
5. Light Broomed Finish: After floating, slabs to receive a light broomed finish shall be power troweled and finished struck with a soft broom rag. The troweling shall produce a smooth surface, relatively free of defects and a Class B Tolerance. Before the surface sets, the soft broom drag shall be passed over the surface to produce a surface uniform in texture and appearance.
6. Troweled Finish: After floating, slabs to receive a troweled finish shall be power troweled and finally hand troweled. The first troweling after power floating shall produce a smooth surface, relatively free of defects. Surfaces shall be hand troweled after the surface has hardened sufficiently. The final troweling shall be done by hand when a ringing sound is produced as the trowel is moved over the surfaces. Hand troweling shall produce a surface which is thoroughly consolidated, free from trowel marks, uniform in texture and appearance and plane to a Class B tolerance.
7. Finishing Tolerance: Surfaces shall be true planes within the following limits:
 - a. Class B: 1/4 inch in 10 feet is determined by a 10 foot straightedge placed anywhere on the slab in any direction.

- I. Saw cut Joints: Joints that are to be saw cut shall be cut not sooner than 2 hours after the concrete is poured and not later than 8 hours after the pour.

3.03 PROTECTING

A. Curing:

1. All exposed surfaces, including slabs, walls, beams and columns shall receive a spray coat of curing compound applied in accordance with the manufacturer's recommendations. Exposed steel keyways and other embedded items shall be protected from the curing compound. Concrete surfaces to be exposed to wastewater and are to be coated with an epoxy system, shall be cured by the wet burlap method. Curing compounds shall not be used on surfaces to be coated and exposed to sewage or wastewater.
2. Curing compound shall be uniformly applied to the surfaces to be cured, in a single coat, continuous film by a mechanical sprayer. Application shall be in compliance with the manufacturer's recommendations.
3. Curing compound shall be applied in accordance with manufacturer's instructions. Should the film become damaged from any cause within the repaired curing period, the damaged portions shall be required immediately with additional compound. Upon removal of forms, the newly exposed surfaces shall immediately be coated to provide a curing treatment equal to that provided for the surface.

- B. Wet Burlap Curing Method: All concrete for wastewater/water retaining structures to be cured by the wet burlap method. All concrete shall be covered with a double thickness of burlap, cotton mats, or other approved material kept thoroughly saturated with water. The forms shall be kept wet until removed and upon removal, the curing specified herein shall be started immediately. Concrete shall be cured for a period of 7 days for normal Portland cement or 4 days for high early strength cement. Concrete poured in the dry shall not be submerged until it has attained sufficient strength to adequately sustain the stress involved nor shall it be subjected to flowing water across its surface until it has cured 4 days. Curing the gunite shall be started as soon as possible without damaging surface and not later than 2 hours after placing. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.

- C. Sheet Material Curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.

3.04 REMOVAL OF FORMS

- A. Except as otherwise specifically authorized by the Engineer, forms shall not be removed before the concrete has attained a strength of at least 70 percent of the 28 day compressive strength prescribed by the design, nor before reaching the following number of day-degrees of curing (whichever is the longer):

<u>Forms for</u>	<u>Degree Days</u>
Beams and slabs	500
Walls and vertical surfaces	100

- B. Shores shall not be removed until the concrete has attained at least 60 percent of the specified strength and also sufficient strength to support safely its own weight and the construction live loads upon it.

3.05 TESTING

- A. An independent testing laboratory employed by the Contractor will make such tests required.
- B. Standard laboratory compressive test cylinders will be obtained by the laboratory when concrete is discharged at the point placing (i.e., discharge end of pumping equipment), and cylinders will be made and cured in accordance with the requirements of ASTM Designation C31. A set of five (5) cylinders will be obtained for each 50 cubic yards, or fraction thereof placed each day, nor less than once for each 5,000 sq. ft. or surface area of slabs or walls for each type of concrete. The cylinders will be cured under laboratory conditions and will be tested in two groups of two (2) at 7 and 28 days of age, with one (1) group held until released by the Engineer in accordance with the requirements of ASTM Designation C39.
- C. The laboratory will conduct tests of Class A and Class B concrete as it is discharged from the mixer at the point of placing. Slump tests will be made for each truckload of concrete. Slump tests may be made on any batch, and failure to meet specified slump requirements will be sufficient cause for rejection of the batch. If water is added after initial test then the "load" shall be tested.
- D. Air content of the concrete mixture will be tested on every other truck in accordance with ASTM C173 or ASTM C231.
- E. Historical strength/break data may be submitted with mix design and may be used in the approval process provided the mix design is otherwise acceptable. If the mix design required modifications, a test batch may still be required.

3.06 FIELD CONTROL

- A. The Contractor shall advise the Engineer of his readiness to proceed at least twenty four (24) working hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment and tightness of formwork. No placement shall be made without the prior approval of the Engineer.
 - 1. The Contractor's Superintendent shall submit a certification that indicates preparedness to place concrete and is in accord with contract drawings and specifications. This certification shall be submitted on forms provided by the Engineer.
- B. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of test on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work.
- C. The Contractor shall cooperate in obtaining cores by allowing free access to the Work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. The Contractor shall repair all core holes. The work of cutting and testing the cores will be at the expense of the Owner.

3.07 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and testing in compliance with the previous provisions fall below the values given in Section 2.02.A.5, the Engineer shall have the right to require changes in proportions outlined to apply on the remainder of the Work. Furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens which failed. The cost of such additional curing shall be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In cases of failure to meet strength requirements the Contractor shall adjust the concrete mix to meet contract requirements.
- B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In case of failure of the core, the Engineer, in addition to other recourses, may require, at the Contractor's expense, load tests on any one of the slabs, beams, piles, caps, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days.

- C. Should the strength of test cylinders fall below 85 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced.

3.08 PATCHING

- A. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed, recesses left by the removal of form ties shall be filled, and surface defect which do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.
- B. Immediately after removal of forms remove plugs and break off metal ties as required by Section 03 11 00-Concrete Formwork. Holes are then to be promptly filled upon stripping as follows: Moisten the hole with water, followed by a 1/16-inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch. Compact the grout into the hole until dense and an excess of paste appears on the surface. Trowel smooth with heavy pressure. Avoid burnishing.
- C. When patching exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with a fine Carborundum stone at an age of one to five days if necessary to bring the surface down to the adjacent concrete. Exercise care to avoid damaging or staining the surrounding concrete. Wash thoroughly to remove all rubbed matter.

3.09 REPAIRS

- A. It is the intent of these Specifications to require quality work including adequate forming, proper mixture and placement of concrete and curing so completed concrete surfaces will not require patching.
- B. Defective concrete and honeycombed areas as determined by the Engineer shall be repaired as specified.
 - 1. General: Surface defects, including tie holes shall be repaired immediately after form removal. The areas to be patched and an area at least 6 inches wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. The Engineer shall be notified prior to commencing operations.
 - 2. Removal of Defective Concrete: All honeycombed and other defective concrete shall be removed down to sound concrete. Edges shall be cut

perpendicular to the surface or slightly under cut. Sand blast surfaces to receive repair.

3. Bonding Grout: Surfaces to be patched shall be thoroughly dampened and shall receive a coat of bonding grout brushed into the surface. Grout shall consist of one part cement to one part fine sand passing a No. 30 sieve. Grout shall be the consistency of thick cream.
4. Placing Patching Mortar: After the bonding grout begins to lose its water sheen, a premixed patching mortar shall be applied. Patching mortar shall be thoroughly consolidated into place and stuck off so as to leave the patch slightly higher than the surrounding surface. It shall be left undisturbed for one hour to permit initial shrinkage and then finally finished.
5. Tie Holes: After being cleaned and thoroughly dampened, the tie holes shall be filled solid with patching mortar.

3.10 MISCELLANEOUS WORK

- A. All bolts, anchors, miscellaneous metals or other sleeves and steel work required to be set in the concrete forms for attachment of masonry, structural, and mechanical equipment shall be set or installed under this Section. The Contractor shall be fully responsible for the setting of such materials in the forms and shall correct all such not installed in a proper location or manner at his own expense. Contractor shall coordinate the activities of other trades for installation of these items.
- B. Electric conduits shall be installed in the concrete as required by the Drawings and specified elsewhere in these Specifications. Outlet boxes and fixtures shall be located in reference to the final floor, wall or ceiling finish and shall be as secured that they will not be displaced by concrete placing.
- C. Pipes or conduits for embedment, other than those merely passing through shall not be larger in outside diameter than one-third the thickness of the slab, wall, or beam in which they are embedded, unless indicated on the Drawings, nor shall they be spaced closer than three (3) diameters on center, nor so located as to unduly impair the strength of the construction. The Engineer shall approve the location of all conduits and fixtures.
- D. Concrete foundations, supports and bases for all equipment and machinery shall be built to the equipment manufacturer's requirements, as approved by the Engineer, with anchor bolts installed.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to finish cast in place concrete surfaces as shown on the Drawings and as specified herein.
- B. All interior concrete floor slabs are to receive concrete sealer unless otherwise noted on the Drawings. Exterior slabs and wet wells or basins do not require a sealer, unless noted otherwise on the Drawings.
- C. Related Work:
 - 1. Division 01: General Requirements
 - 2. Section 03 11 00: Concrete Formwork
 - 3. Section 03 31 00: Cast-in-Place Concrete
 - 4. Section 03 60 00: Grout
 - 5. Section 09 90 00: Painting and Coating

1.02 SUBMITTALS

- A. Submit shop drawings and product data, in accordance with Division 01 - General Requirements and 01 33 26 - Submittals, showing materials of construction and details of installation for:
 - 1. Concrete sealer. Conformation that the sealer is compatible with additionally applied coating shall also be submitted.

1.03 REFERENCE STANDARDS

- A. Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following, as applicable:
 - 1. American Society for testing and materials (ASTM)
 - a. ASTM C33 – Standard specification for concrete aggregates

- B. Where reference is made to standards of one of the above, or other organizations, the version of the standard in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

A. Finishes

1. For concrete which will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finishes are required and provide the proper finishes to receive these products.
2. Changes in finishes made to accommodate products different from those specified shall be performed at no additional cost to the Owner. Submit the proposed new finishes and their construction methods to the Engineer for approval.

B. Services of manufacturers representative

1. The Contractor shall make available at no extra cost to the Owner, upon 72 hours notification, the services of a qualified field representative of the manufacturer of concrete sealer to instruct the user on the proper application of the product under prevailing job conditions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete sealer shall be a silicate based sealer and shall be "Protecrete" by Advanced Concrete Technology Inc., Arlington Heights, Illinois: "Sonosil" by Sonneborn Building Products, Minneapolis, Minnesota: or equal as approved by the Engineer.

PART 3 - EXECUTION

3.01 FORMED SURFACES

- A. Forms shall not be removed before the requirements of section 03 31 00, Cast-in-Place Concrete, have been satisfied.
- B. Exercise care to prevent damaging edges or obliterating the lined of chamfers, rustications or corners when removing the forms or performing any other work adjacent thereto.

- C. Prepare the exposed surface as specified in Section 03300, Cast-In-Place Concrete.
- D. As – cast finish.
 - 1. No additional finishing is required.
- E. Rubbed Finish
 - 1. While the wall is still damp apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to prove a bonding coat within all pits, air holes, or blemishes in the parent concrete. Avoid coating large areas with the slurry at one time.
 - 2. Before the slurry has dried or changed color, apply a dry (almost crumbly) grout proportioned by volume and consisting of one part cement to 1-1/2 parts of clean masonry sand having a fineness modulus of approximately 2.3 and complying with the gradation requirements of ASTM C33 for such a material. Grout shall be uniformly applied by means of damp pads of coarse burlap approximately 6 sq in, used as a float. Scrub grout into the pits and air holes to provide a dense mortar in all imperfections.
 - 3. Allow the mortar to partially harden for 1 to 2 hours depending upon the weather. If the air is hot and dry, keep the wall damp during the period using a fine, fog spray. When the grout has hardened sufficiently so it can be scrapped from the surface with the edge of steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel. (Note: Grout allowed to remain on the wall too long will harden and will be difficult to remove.)
 - 4. Allow the surface to dry thoroughly and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cutoff with the trowel so it can be wiped off clean with the burlap.
 - 5. On the day following the repair of pits, air holes and blemishes the walls shall again be wiped off clean with dry, used pieces of burlap containing old hardened mortar which will act as a mild abrasive. After this treatment, there shall be no built- up film remaining on the parent surface. If, however, such a film is present, a fine abrasive stone shall be used to remove all such materials without changing the texture of the concrete.

6. A thorough wash down with stiff bristles shall follow the final bagging or stoning operation. No extraneous materials shall remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least three days after the application of the repair grout.

3.02 FLOOR AND SLABS

A. Floated Finish:

1. Machine Floating

- a. Screed floors and slabs with straightedges to the established grades shown on the Drawings. Immediately after final screeding, a dry cement/sand shake in the proportion of two sacks of Portland cement to 350 lbs of coarse natural concrete sand shall be sprinkled evenly over the surface at the rate of approximately 500 lbs per 1,000 sq ft of floor. Do not sprinkle neat, dry cement on the surface.
- b. The application of cement /sand may be eliminated at the discretion of the Engineer if the base slab concrete exhibits adequate fattiness and homogeneity, and he needs not indicated. When the concrete has hardened sufficiently to support the weight of a power float without digging into or disrupting the level surface, thoroughly float the shake into the surface with a heavy revolving disc type power compacting machine capable of providing a 200 lb. compacting force distributed over a 24-in diameter disc.
- c. Start floating along the walls and around columns and then move systematically across the surface leaving a matte finish.
- d. The compacting machine shall be the "Kelly power float with compaction control" as manufactured by Kelley Industries of SSP Construction Equipment, Inc. Pomona California, or approved equal. Troweling machines equipped with float (shoe) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades shall not be permitted. The use of any floating or troweling machine which has a water attachment for wetting the concrete surface during finishing shall not be permitted.

2. Hand Floating

- a. In lieu of power floating, small areas may be compacted by hand floating. The dry cement/sand shale previously specified shall be used unless specifically eliminated by the Engineer. Screed the floors and slabs with straightedges to the established grades shown on the Drawings. While the concrete is still green, but sufficiently hardened to support a finisher and kneeboards with no more than ¼-in indentation, wood float to a true, even plane with no coarse aggregate visible. Use sufficient pressure on the wood floats to bring moisture to the surface.
- 3. Toweling
 - a. All floor slabs shall receive a light trowel finish, unless otherwise specified.
- 4. Finishing tolerances
 - a. Level floors and slabs to a tolerance of plus or minus ½-in when checked with a 10-ft. straightedge placed anywhere on the slab in any direction. Where drains occur, pitch floors to drains such that there are no low spots left un-drained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other correction as directed by the Engineer at Contractor's expense.
- B. Broom Finish
 - 1. Screed slabs with straightedges to the established grades indicated on the Drawings. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a stiff bristle broom lightly across the surface in the direction of drainage, or, in the case of walk and stairs, perpendicular to the direction of traffic to provide a non-slip surface.
- C. Steel Trowel Finish
 - 1. Finish concrete as specified in paragraph 3.02A. Power trowel surface and then hand steel trowel to a perfectly smooth hard even finish free from high or low spots, trowel marks, or other defects.
- D. Concrete Sealer
 - 1. Prepare and seal surfaces indicated on the room finish schedule to receive a sealer as follows:
 - a. Finish concrete as specified in paragraph 3.02A.

- b. Newly placed concrete: Surface must be sound and properly finished. Surface is application-ready when it is damp but not wet and can no longer be marred by walking workman.
- c. Newly-Cured bare concrete: Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt, and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that surface is no more than damp, and not wet.
- d. Aged concrete: Restore surface soundness by patching, grouting, filling cracks, and holes, etc. Surface must also be free of any dirt, dust, and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required, following the procedure indicated under cured concrete.
- e. Methods: Apply sealer so as to form a continuous, uniform film by spray, soft-bristle push broom, long-nap roller, or lambs wool applicator. Ordinary garden-type sprayers using neoprene hose, are recommended for best results.
- f. Applications: Apply first coat evenly and uniformly as soon as possible after final finishing. Apply second coat when all trades are completed and structure is ready for occupancy.
- g. To seal and dustproof, two coats are required. For sealing new concrete, both coats shall be applied full-strength. On aged concrete, when renovating, dust proofing and sealing, the first coat should be thinned per manufacturer's directions.

3.03 APPROVAL OF FINISHES

- A. All concrete surfaces, when finished, will be inspected by the Engineer.
- B. Surfaces which, in the opinion of the Engineer, are unsatisfactory shall be refinished or reworked.
- C. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03300, Cast in place concrete, unless otherwise directed by the Engineer.

3.04 SCHEDULE OF FINISHES

- A. Concrete shall be finished as specified either to remain as natural concrete to receive an additional applied finish or material under another Section.

- B. Concrete for the following conditions shall be finished as noted on the Drawings and as further specified herein:
1. Concrete to receive damproofing: As-cast finish See paragraph 3.01D
 2. Concrete not exposed to view and not scheduled to receive an additional applied finish or material: As-cast finish See paragraph 3.01D
 3. Exterior vertical concrete above grade exposed to view: Rubbed finish. See paragraph 3.01E
 4. Interior vertical concrete exposed to view except in water containment areas: Rubbed finish. See paragraph 3.01E
 5. Vertical concrete in Water containment areas: Rubbed finish on exposed surfaces and extending at 2-ft below normal operating water level: As-cast finish on remainder of submerged areas. See paragraph 3.01E and 3.01D
 6. Interior and exterior underside concrete exposed to view: Rubbed Finish. See paragraph 3.01E
 7. Concrete to be painted: Rubbed finish. See paragraph 3.01E
 8. Concrete to receive heavy duty or extra heavy-duty concrete topping: Light broomed finish.
 9. Concrete to receive floor sealer: See paragraph 3.02D
 10. Concrete slabs noted to receive steel trowel finish: See paragraph 3.02C.
 11. Concrete for exterior walks, interior and exterior stairs: Broomed finish perpendicular to direction of traffic. See paragraph 3.02B
 12. Interior and exterior horizontal concrete not required or steel trowel finish: Floated finish. See paragraph 3.02A
 13. Concrete surfaces to be covered with grout: See paragraph 03600
 14. Concrete to receive ceramic tile: Steel trowel

END OF SECTION

SECTION 03 42 00

PRECAST, PRESTRESSED CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install the precast, prestressed roof slabs and accessories as shown on the Drawings and as specified herein.
- B. The work of this Section includes but is not necessarily limited to:
 - 1. All inserts, weld plates, strand anchors, bolts, anchor bolt, slip angles, bearing plates, pipe sleeves and reinforcing bars which are cast into the prestressed concrete members as indicated on Drawings.
 - 2. Furnish and place all anchors, weld plates, inserts, reinforcing bars and other accessories in cast-in-place concrete as required for installation of the work under this Section.
 - 3. Erection including all necessary shimming and welding and removal of lifting hooks.

1.02 RELATED WORK

- A. Concrete Reinforcing is included in Section 03 21 00.
- B. Cast-In-Place Concrete is included in Section 03 31 00.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01 33 23, complete shop drawings and calculations for all members. The shop drawings and calculations shall be prepared and stamped by a registered professional engineer. Fabrication of members shall not proceed until shop drawings are approved by the Engineer. Submit installation and handling literature and requirements for drilling and cutting openings in the field.
- B. All inserts, hangers, openings, pipe sleeves, blockouts, etc, required by various trades or as indicated, located and detailed on the final approved drawings will be cast as such and any omission or changes in location or details or various trades shall be done at the expense of the Contractor.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A36 – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 3. ASTM A416 – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - 4. ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 5. ASTM C33 – Standard Specification for Concrete Aggregates.
 - 6. ASTM C150 – Standard Specification for Portland Cement.
- B. American Concrete Institute (ACI)
 - 1. ACI 318 – Building Code Requirements for Structural Concrete.
- C. American Association of State Highway and Transportation Officials (AASHTO).
 - 1. AASHTO HB-13 – Standard Specifications for Highway Bridges.
- D. American Welding Society (AWS)
 - 1. AWS D1.1 – Structural Welding Code-Steel.
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. All prestressed structural concrete elements shall be manufactured at an existing plant and satisfactory evidence shall be given the Engineer to substantiate that the fabricator is capable of and has the organization and plant for, performing the work and of maintaining the schedule required. The manufacturer of these elements must also submit a record of his\her work for the 5 years to substantiate that he\she has been manufacturing prestressed members.

1.06 DESIGN CRITERIA

- A. The design and construction of prestressed members shall conform to the ACI 318.

- B. Furnish two copies of design calculations to the Engineer for approval. Calculations shall indicate all assumptions and cover all phases of design. All elements shall be designed to support their own weight, plus the superimposed loads shown on the Drawings. Calculations shall also include the amount of camber produced, together with the dead and live load deflections. Fabrication shall not be started until written approval of the design calculations has been received.
- C. The thickness of the elements has been established and is indicated on the Drawings. All steel, mild or strand, shall have a minimum of 2-in of concrete cover. All concrete elements shall have shear keyways on the sides of the members which will be placed adjacent to other elements.
- D. The precast prestressed members shall be designed for the following superimposed loads:
 - 1. Concrete topping at a density of 150 pounds per cubic foot to the thickness indicated on the Drawings.
 - 2. Dead load and live load as indicated on the Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All cement, sand and gravel used in this Section of work including patching of members shall be obtained from one single source to ensure as uniform a texture as possible.
- B. Cement shall be portland cement conforming to ASTM C150, Type III.
- C. Aggregates shall consist of sand and gravel conforming to ASTM C33. Size of coarse aggregate shall meet spacing requirements of prestressing steel and/or reinforcing steel. The maximum size of aggregate shall be no larger than 1-in.
- D. Reinforcing steel shall be intermediate grade, new billet steel and deformed in accordance with ASTM A615, Grade 60. Cast-in anchor plates, weld plates and angle headers with clips shall conform with ASTM A36. Prestressing strand shall conform to the ASTM A416, Grade 250K.
- E. Non-shrink grout shall be Masterflow 713 by Master Builders Company; Euco N-S by Euclid; Five Star Grout by US Grout Corp or equivalent.

PART 3 EXECUTION

3.01 CONCRETE STRENGTH

- A. All prestressed concrete members shall have a minimum 28-day compressive strength of 5,000 psi using Type III cement.

- B. Unless otherwise specified by the Engineer, concrete shall have a minimum compressive strength of 3,500 psi at transfer of prestressing force, as determined by test.

3.02 FABRICATION

- A. All exposed surfaces shall be steel formed and tops of roof members shall have a wood float finish. All members shall be steam cured at 130 to 160 degrees F. All corners shall have minimum 1/2-in chamfer.
- B. Sizes of all members shall conform to those shown on the Drawings with the following dimensional tolerances:
 - 1. Cross sectional tolerance for all members shall be plus 1/4-in minus zero-in.
 - 2. Length of members shall be plus or minus 3/8-in.
 - 3. Ends of members out of square shall be plus or minus 1/4-in plus.
 - a. Deviation from straight line shall be not greater than 1/8-in per 10-ft of length measured by a light line stretched from end to end of unit.
 - b. Difference in camber between two adjacent slabs in place after welding shall not be more than 1/2-in.

3.03 HANDLING AND ERECTION

- A. All prestressed units shall be carefully loaded and hauled on trucks and erected to prevent damage. They shall be erected by experienced workmen, true to line and grade in proper sequence, welded and/or anchored as indicated on Drawings. All members superficially damaged during shipment or erection shall be rejected until they are repaired by experienced workmen. Units badly damaged shall be rejected until they are replaced. The Engineer shall be the sole judge of this damage. No holes shall be cut or drilled in the field without written approval of the Engineer.
- B. Connections between roof slabs shall be as required on the Drawings. Seal all longitudinal joints prior to placing grout. All welding shall be in accordance with AWS D1.1. Bolts shall be low carbon steel conforming to ASTM A307.

3.04 TESTS

- A. At least three standard test specimens for each production line shall be prepared in accordance with Section 4.7 of ACI 318, at the time the concrete is deposited to determine the concrete strength at different ages.
- B. All testing of products or concrete strength tests to be done by the outside testing laboratory selected by the Contractor and Owner will be done at the expense of the

Contractor; except test of specimens for strength at transfer of prestressing force (see Paragraph 3.01 above) shall be made and observed by the laboratory if so desired.

END OF SECTION

SECTION 03 60 00

GROUT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work included in this Section consists of grouting the various items listed hereinafter and indicated on the Drawings.

1.02 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01 33 23, Submittals, showing materials of construction and details of installation for:
 - 1. Commercially manufactured nonshrink cementitious grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.
 - 2. Commercially manufactured nonshrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.
 - 3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures and the proposed mix of the grout.
 - 4. Concrete grout. The submittal shall include the mix design, constituent quantities per cubic yard and the water/cement ratio.
- B. Laboratory Test Reports
 - 1. Submit laboratory test data as required for concrete to be used as concrete grout.
- C. Certifications
 - 1. Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with wastewater after 3 days curing.
- D. Qualifications

1. Grout manufacturers shall submit documentation that they have at least 10 years experience in the production and use of the proposed grouts which they will supply.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Specification for Concrete Aggregates
2. ASTM C150 - Specification for Portland Cement
3. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes
4. ASTM C579 - Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes
5. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
6. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
7. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics.

B. U.S. Army Corps of Engineers Standard (CRD)

1. CRD C-621 - Corps of Engineers Specification for Nonshrink Grout

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

A. Qualifications

1. The Contractor shall submit certification documents showing that application Contractor have at least 3 years experience in the use of the proposed grouts which they will use.

B. Pre-installation Conference

1. Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.

C. Services of Manufacturer's Representative

1. A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend the pre-installation conference and shall be present for the initial installation of each type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems.

D. Field Testing

1. All field testing and inspection services required shall be provided by the Contractor using an independent third-party test lab. The Contractor shall sample the materials and shall provide any ladders, platforms, etc, for access to the work. The methods of testing shall comply in detail with the applicable ASTM Standards.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.
- C. Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the Owner.
- D. Nonshrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.
- E. Nonshrink epoxy grouts shall be delivered as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Nonshrink Cementitious Grout

1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD C-621. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.
 - a. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Set Grout by Master Builders, Inc.; Gilco Construction Grout by Gifford Hill & Co.; Euco NS by The Euclid Chemical Co.; NBEC Grout by U. S. Grout Corp. or equivalent.
 - b. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders, Inc.; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Supreme Grout by Gifford Hill & Co.; Five Star Grout by U. S. Grout Corp. or equivalent.

B. Nonshrink Epoxy Grout

1. Nonshrink epoxy-based grout shall be a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30×10^{-6} when tested in conformity with ASTM C531. The grout shall be Ceilcote 648 CP by Master Builders Inc.; Five Star Epoxy Grout by U.S. Grout Corp.; Sikadur 42 Grout-Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co. or equivalent.

C. Cement Grout

1. Cement grouts shall be a mixture of one part portland cement conforming to ASTM C150, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout

1. Concrete grout shall be proportioned with cement, pozzolan (below the water line), coarse and fine aggregates, water, water reducer and air

entraining agent to produce a mix having an average strength of 2500 psi at 28 days, or 2500 psi nominal early strength. Coarse aggregate size shall be 3/8-in for small repair or 1/2-in maximum large repair. Slump should not exceed 5-in and should be as low as practical yet still retain sufficient workability.

2. Synthetic reinforcing fibers shall be added to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

E. Water

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Grout shall be placed over cured concrete which has attained its full design strength unless otherwise approved by the Engineer.
- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may effect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
 1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.
- D. Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of baseplates prior to the installation of the grout.
- E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24 hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface

saturation shall only be used when approved by the Engineer for each specific location of grout installation.

- F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- G. Construct grout forms or other leakproof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.
 - 1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- H. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.02 INSTALLATION - GENERAL

- A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 60 and 90 degrees F during grouting and for at least 24 hours thereafter or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.
- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.
- E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

- F. Reflect all existing underlying expansion, control and construction joints through the grout.

3.03 INSTALLATION - CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

- A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.
- B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
- C. Placements greater than 3-in in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.
- D. Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.
- G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION - NONSHRINK EPOXY GROUTS

- A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.
- C. Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- F. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.05 INSTALLATION - CONCRETE GROUT

- A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of concrete grout.
- B. Remove the debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.
- C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use of soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste. [(A bonding grout composed of 1 part portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)]

- D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.
- E. Provide grout control joints as indicated on the Drawings.
- F. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.06 SCHEDULE

- A. The following list indicates where the particular types of grout are to be used:
 - 1. General purpose nonshrink cementitious grout: Use at all locations where non shrink grout is called for on the plans except for base plates greater in area than 3-ft wide by 3-ft long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.
 - 2. Flowable nonshrink cementitious grout: Use under all base plates greater in area than 3-ft by 3-ft. Use at all locations indicated to receive flowable nonshrink grout by the Drawings. The Contractor, at his/her option and convenience, may also substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.
 - 3. Nonshrink epoxy grout: Use for the setting of anchor rods, anchor bolts and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.
 - 4. Cement grout: Cement grout may be used for grouting of incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.
 - 5. Concrete grout: Use for overlaying the base concrete to allow more control in placing the surface grade.

END OF SECTION

SECTION 03 80 00

LEAKAGE TESTING OF HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Test concrete hydraulic structures for leakage as described herein.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Water: Potable.
- B. Piping: As required to fill and empty structures.
- C. Equipment: As required to fill and empty structures.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Hydrostatically test concrete structures which are intended to contain liquid to determine that they are watertight and free of detectable leaks.

3.02 INSPECTION AND TESTING

- A. Prior to testing, clean exposed surfaces by thorough hosing and remove all loosened matter and wash water from the structures.
- B. Conduct testing before backfill is placed against walls and after all concrete has attained the specified compressive strength.
- C. Fill hydraulic structures to be subjected to leakage tests with water to the normal liquid level line. Do not fill more than 36 inches of water depth per day, unless otherwise approved by the Engineer. Repair any running leaks which appear during filling before continuing. After the structure has been kept full for 48 hours, it will be assumed, for the purposes of the tests, that the absorption of moisture by the concrete in the structure is complete. Then, close all valves and gates to the structure and measure the change in water surface each day for a five-day period.
- D. During the test period, examine all exposed portions of the structure, and mark all visible leaks or damp spots. Repair such leaks or damp spots later. If the drop in

water surface in a 24 hour period exceeds 1/10 of 1 percent of the normal volume of liquid contained in the structure, the leakage will be considered excessive.

- E. If the leakage is excessive, drain the structure, repair leaks and damp spots, refill the structure and again test for leakage. Continue this process until the drop in water surface in a 24 hour period, with the structure full, is less than 1/10 of 1 percent of the volume.
- F. Evaporation and precipitation rates shall be independently measured as part of the leakage test.
- G. Make repairs and additional tests at no additional cost to the Owner.
- H. Apply specified coatings only after acceptance of leakage testing by the Engineer.

3.03 REPAIR METHODS

- A. Repair concrete not passing the leakage test in conformance with the applicable provisions of Division 03 and to the satisfaction of the Engineer.

END OF SECTION

SECTION 05 10 00

STRUCTURAL METAL FRAMING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work under this Section includes structural steel, connectors, and miscellaneous metal work shown on the Contract Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related Sections:
 - 1. Division 01: General Requirements

1.02 REFERENCES

- A. General: The work shall comply with the most recent standards or tentative standards as published at the date of the contract and as listed in this specification using the abbreviation shown.
- B. American Society for Testing and Materials (ASTM):
 - 1. A36/A36M Standard Specification for Carbon Structural Steel
 - 2. A53/A53M Standard Specification for Pipe Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
 - 3. A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 - 4. A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 - 5. B308/B308M Standard Specification for Aluminum Alloy 6061-T6 Standard Structural Profiles
- C. American Welding Society (AWS):
 - 1. D1.1 Structural Welding Code Steel
- D. Steel Structures Painting Council (SSPC):
 - 1. SP-11 Power Tool Cleaning to Bare Metal

1.03 SUBMITTALS

- A. General: Submittals shall be in accordance with Division 01 – General Requirements and Section 01 33 23 – Submittals.
- B. Shop Drawings: Detail fabrication of structural steel and aluminum components. Include details of cuts, connections, splices, camber, and other pertinent data.

1.04 QUALITY ASSURANCE

- A. Qualifications: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Welding: Shop and/or field welding required in connection with the work of this Section shall be performed in strict accordance with pertinent AWS recommendations.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Delivery, Storage, and Handling shall be in accordance with Division 01 – General Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General: In fabricating items which will be exposed to view, limit materials to those which are free from surface blemishes, pitting, rolled trade names, and roughness.
- B. Steel: Shall comply with the following standards as minimum:
 - 1. Steel plates and shapes - ASTM A36.
 - 2. Steel Tubing (Hot Formed, welded, or seamless) - ASTM A501.
 - 3. Steel Pipes - ASTM A53, Type E or S, Grade B.

2.02 FASTENERS

- A. General: Fasteners for all uses shall be Zinc coated steel. Provide fasteners of type, grade, and class required for the particular use.
- B. Fasteners: Machine bolts, nuts, and washers shall comply with ASTM A307.

2.03 SHOP PAINT

- A. Primer: Use "10-99 Tnemec Primer" or "Rustoleum Number 5769 Primer"
- B. Repair: Galvanized shall be repaired using a high Zinc dust content paint.

2.04 ALUMINIUM GRATING

- A. General: Grating shall be fabricated from aluminum rolled or extruded shapes or piping meeting Aluminum Association standards for other fabrications.
- B. Grating: Grating shall be fabricated with rectangular bearing bars placed edgewise and assembled with cross bars welded or pressed into place. Design shall provide for 100 pounds per square foot live load plus a 1,000 pound concentrated load at mid-span of any tread.

PART 3 – EXECUTION

3.01 FABRICATION

- A. General: Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.
- B. Protection: Masonry construction shall be protected from direct exposure to wind and sun when erected in ambient air temperature of 99 degrees F in the shade and with relative humidity less than 50 percent.

3.02 PAINTING

- A. Cleaning: Prior to the shop painting or priming, metal surfaces shall be cleaned according to Steel Structures Painting Council SP-11.
- B. Painting: Primer shall be applied to a 1.5 dry mill thickness.
- C. Special Application: On surfaces inaccessible after assembly or erection two coats of the specified primer shall be applied. Change color of second coat to distinguish it from the first.

3.03 INSTALLATION

- A. General: Work in this section shall be installed in strict accordance with original design, the approved shop drawings, and the manufacturer's recommended installation procedures.
- B. Installation: Shall comply with the following:

1. Set work accurately into position and anchor it firmly.
2. Where field welding is required comply with AWS recommended procedures of Manual Shielded Metal Arc welding for appearance and quality of weld and for methods to be used in correcting welding work.
3. Grind exposed welds smooth and touch up shop prime coats.
4. Neoprene gaskets or mastic coating shall be used for protection of dissimilar metals wherever aluminum is in contact with concrete or with ferrous metals.
5. Do not cut, weld, or abrade surfaces which have been Hot Dipped galvanized after fabrication, and which are intended for bolted or screwed field connections.
6. Immediately after erection, clean the field welds, bolted connections and abraded areas of shop priming. Paint the exposed areas with the same material used for shop priming.

END OF SECTION

SECTION 05 05 00

METAL FASTENING

PART 1 --GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall perform the Work under this Section and as specified herein.
- B. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05 01 00 – Structural Metal Framing
- B. Section 05 14 00 – Structural Aluminum

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

- 1. Florida Building Code
- 2. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- 3. AISC Code of Standard Practice
- 4. AWS D1.1 Structural Welding Code -Steel
- 5. AWS D1.2 Structural Welding Code -Aluminum
- 6. Aluminum Association Specifications for Aluminum Structures
- 7. ASTM A572/A572M-94C Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
- 8. ASTM A307 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
- 9. ASTM A325 Standard Specification for High-Strength

Bolts for Structural Steel Joints

10.	ASTM A489	Standard Specification for Eyebolts
11.	ASTM A490	Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
12.	ASTM A563	Standard Specifications for Carbon and Alloy Steel Nuts
13.	ASTM F593	Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
14.	ASTM F594	Standard Specification for Stainless Steel Nuts
15.	ASTM D1785	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
16.	ASTM F467	Standard Specification for Nonferrous Nuts for General Use

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 23, Submittals.
 - 1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.
 - 2. Copy of valid certification for each person who is to perform field welding.
 - 3. Certified weld inspection reports, when required.
 - 4. Welding procedures.

1.05 QUALITY ASSURANCE

- A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.
- B. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. Certifications of field welders shall be submitted prior to performing any field welds.

- C. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.
- D. NAU may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of NAU and/or an acceptable independent testing laboratory, at no additional cost to NAU.
- E. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.

PART 2 --PRODUCTS

2.01 ANCHOR BOLTS

- A. Anchor bolts shall be Type 316 stainless steel or other approved anchor bolts as shown on the Drawings. Anchor bolts shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594.
- B. Unless otherwise specified or shown on the Drawings, anchor bolts and nuts shall be Type 316 stainless steel.
- C. Where pipe sleeves around anchor bolts are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.02 HIGH STRENGTH BOLTS

- A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
- B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners shall be Type 316 stainless steel.
- B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the

bolts.

2.04 CONCRETE ANCHORS

- A. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. Unless otherwise noted, all concrete anchors which are submerged, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by a commercial testing laboratory. There are two types used:
- 1 Expansion anchors shall be wedge, sleeve, or drop-in mechanical anchors.
 - 2 Adhesive anchors shall be two part injection type.
- B. Expansion anchors shall be Kwik Bolt II by Hilti, Inc., or Trubolt Wedge Anchor by ITW Ramset/Redhead and shall be embedded to the depths shown on the Drawings. If no embedment depth is given, the minimum embedment depth as recommended by the manufacturer shall be used.
- C. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt (see Table 1) unless noted otherwise on the Drawings. The adhesive system shall be "Sikadur Injection Gel" as manufactured by Sika Corporation, "Epcon System" as manufactured by ITW Ramset/Redhead, or "HIT HY-150 Injection Adhesive Anchor System" as manufactured by Hilti, Inc.
- D. Concrete anchors used to anchor steel shall be hot dipped galvanized steel unless noted otherwise on the drawings, or noted herein.
- E. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 316 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.

TABLE 1 Allowable Tensile Capacity (Kips)		
Size	A36 Threaded Rod/Bolt	SST Threaded Rod/Bolt
3/8"	2.1	1.9
1/2"	3.8	3.5
5/8"	5.9	5.6
3/4"	8.4	8.2
7/8"	11.5	11.4
1"	15.0	15.0

2.05 Masonry anchors

- A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.
- B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall be injected into the screen tube with a static mixing nozzle. The adhesive system shall be "Epcon System" as manufactured by ITW Ramset/Redhead, "HIT HY-20 System" as manufactured by Hilti, Inc, or equal.
- C. Masonry anchors used to anchor steel shall be hot dipped galvanized steel unless noted otherwise.
- D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 316 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

2.06 WELDS

- A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).
- B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.
- C. Electrodes for welding stainless steel and other metals shall comply with AWS code.

2.07 WELDED STUD CONNECTORS

- A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.08 EYEBOLTS

- A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.09 HASTELLOY FASTENERS

- A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

2.10 ANTISEIZE LUBRICANT

- A. Antiseize lubricant shall be Graphite 50 Anti-Seize by Loctite Corporation, 1000 Anti-Seize Paste by Dow Corning, 3M Lube and Anti-Seize by 3M, or equal.

PART 3 --EXECUTION

3.01 MEASUREMENTS

- A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to NAU for clarification prior to starting fabrication.

3.02 BOLT INSTALLATION

A. Anchor Bolts, Concrete Anchors, and Masonry Anchors

- 1 Anchor bolts shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template.
- 2 The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.
3. Concrete anchors shall not be used in place of anchor bolts without NAU approval.
4. All stainless steel threads shall be coated with antiseize lubricant.

B. High Strength Bolts

- 1 All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC "Specification for Structural Joints, using A325 or A490 Bolts." All high strength bolts installed by the "turn-of-nut" method shall have the turned portion marked with reference to the steel being connected after the nut has been made snug and prior to final tightening. These marks will be considered in inspection.
- 2 All stainless steel bolts shall be coated with antiseize lubricant.

C. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal. Unless otherwise specified, where aluminum and steel members are connected together they shall be fastened with Type 316 stainless steel bolts and insulated with micarta, nylon, rubber, or equal.

3.03 WELDING

- A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

- B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.04 INSPECTION

- A. High strength bolting will be visually inspected in accordance with AISC "Specification for Structural Joints Using A325 or A490 Bolts." Rejected bolts shall be either replaced or retightened as required. In cases of disputed bolt installation, the bolts in question shall be checked by a calibrated wrench certified by an independent testing laboratory. The certification shall be at the Contractor's expense.
- B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment and incidentals necessary to install structural steel including bearing plates, columns, beams, and miscellaneous shapes and plates required to erect the structural framing as shown on the Drawings and specified herein.
- B. Furnish anchor bolts with templates to be installed under Division 03. Furnish and install nuts and washers for anchor bolts.
- C. Install portions of masonry ties to be welded to structural steel as shown on the Drawings and as specified herein.

1.02 Related Work Described Elsewhere:

- A. Cast-In-Place Concrete: Section 03 31 00.
- B. Painting and Coating: Section 09 96 00.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01 33 23: Submittals, detailed erection drawings, schedules, and data for all structural steel. Drawings shall bear the seal of professional engineer registered in the State of Florida. Approval will be for strength only and shall not relieve the Contractor of responsibility for proper fit of members, of connections not detailed on the Drawings, or for supplying all material required by the Contract Documents. Mark numbers painted on the shop assembled pieces of steel shall be the same mark numbers used on the detailed shop and erection drawings.
- B. Certified mill test reports for the structural steel and the bolting materials.
- C. Certifications that welders are qualified, in accordance with AWS D1.1, on the shop and field welding procedures to be used.

1.04 REFERENCE STANDARDS

- A. American Institute of Steel Construction (AISC)
 - 1. Code of Standard Practice for Steel Buildings and Bridges.

2. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
- B. American Society for Testing and Materials (ASTM)
1. ASTM A36 - Standard Specification for Structural Steel.
 2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless
 3. ASTM A123 - Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
 4. ASTM A307 - Standard Specification for Carbon Steel Externally Threaded Standard Fastener.
 5. ASTM A325 - Standard Specification for High Strength Bolts for Structural Steel Joints.
 6. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 7. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- C. American Welding Societies (AWS)
1. AWS A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
 2. AWS D1.1 - Structural Welding Code Steel.
- D. Local Codes
1. Florida Building Code.
- E. Steel Structures Painting Council (SSPC)
1. Steel Structures Painting Council (SSPC), Surface Preparation Specifications.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver anchor bolts and other anchorage devices which are to be embedded in the work of other trades to the project site in sufficient time to permit their timely

installation. Provide proper setting drawings, templates and directions for installation of these items.

- B. Store structural steel members above ground on platforms, skids or other supports. Store all fasteners and welding electrodes in a weather-tight and dry place until ready for use. Store packaged materials in their original containers.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Shapes, Plates and Bars: ASTM A-36.
- B. Structural Tubing: ASTM A-500, Grade B ($F_y = 46$ ksi).
- C. Bolts:
 - 1. Anchor Bolts: Type 316 Stainless Steel.
 - 2. Structural Steel: ASTM A-325.
- D. Welding Electrodes: As permitted by AWS Code.
- E. Shop Paint Primer: See Section 09900.

2.02 FABRICATION

- A. Fabrication shall meet all requirements of the specified standards.
- B. Fabricate and assemble structural steel in the shop to the greatest extent possible. Do all shearing and flame cutting carefully and accurately using machine equipment where possible.
- C. Match-mark materials for field assembly. Ream unmatched holes in shop assembly of field connections. Reject and replace with new pieces any piece weakened by reaming to a point where the strength of the joint is impaired.
- D. Weld connections or bolt as indicated. Weld shop connections not otherwise shown. Eccentric connections are not permitted unless shown in detail on the structural Drawings. Bolted connections shall have a minimum of two bolts.

2.03 SURFACE PREPARATION AND SHOP COATINGS

- A. Prepare and shop prime paint non-galvanized members as specified in Section 09 96 00 Painting and Coating. Do not prime paint faying surfaces of slip critical connections.

- B. Galvanize members and their attachments exposed in whole or part to the weather, including beams supporting exterior masonry. Galvanize other members as indicated on the Drawings. Galvanizing shall be done after fabrication and in accordance with ASTM A123. Thoroughly clean, pickle; flux, and immerse members in bath of molten zinc until their temperature becomes the same as the bath. Coating shall be 2-oz. per sq. ft.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before starting work, verify locations and elevations of bearings and anchor bolts. Immediately report inaccuracies. Work under this Section includes responsibility for accurate bearing of steel and correct location of anchorage.

3.02 ERECTION

- A. Erection shall be in accordance with the requirements of the specified standards.
- B. Weld field connections or bolt as indicated.
- C. Bolting:
 - 1. As erection progresses, bolt up work to take care of all dead loads, construction live loads, lateral forces and erection stresses.
 - 2. Unless otherwise noted, erection bolts used in welded construction may be either tightened securely and left in place or removed and the holes filled with plug welds.
 - 3. Drift pins may be used for assembling parts provided metal is not distorted or holes enlarged. Ream holes requiring enlargement to admit bolts. Misaligned holes will subject members to rejection.
 - 4. Make all steel to steel connections by high strength bolting except where field welding is specifically shown. Provide not less than two ¾-in bolts per connection and use not less than ¼-in thick clip angles.
 - 5. Tighten bolted connections designated as bearing-type connections to the snug tight condition. Where specified, tighten other bolted connections to full pretension by turn-of-nut or calibrated wrench tightening.
- D. Welding:

1. Field welding shall be done only where shown or specified and only by welders qualified for the procedures used. No welding shall be done when surfaces are wet, exposed to rain or wind, or when welders are exposed to inclement conditions that will hamper good workmanship.
 2. Each welder shall be assigned an identification mark. This mark shall be made at each completed connection with a paint stick.
- E. Temporary Bracing: Introduce wherever necessary to provide for all loads to which structure is subjected including erection equipment and its operation. Leave in place until no longer required for safety. Make proper provisions for construction loads, piles of materials, equipment, etc., carried by structural frame during erection.
- F. Touch-up Painting: After erection, clean all fixed connections (bolts and welds) as specified in Section 09 96 00 and spot paint all abrasions with same primer as used in shop. Finish painting shall be as specified in Section 09 96 00.
- G. Zinc coating which has been burned by field welding, abraded, or otherwise damaged shall be cleaned and repaired after erection of structural steel. The damaged area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint.

3.03 INSPECTION

- A. The Engineer shall have free access to the work. The Contractor shall notify the Engineer in writing four (4) days in advance of any welding or high strength bolting operations.
- B. High-strength bolting may be visually inspected. All high-strength bolts shall have the turned portion marked with reference to the steel being connected after the nut has been made snug and prior to final tightening. These marks shall be considered in the inspection. Rejected bolts shall be either replaced or retightened as required. In cases of disputed bolt installations, the bolts in question shall be checked by a calibrated wrench certified by an independent testing laboratory selected by the Owner.
- C. Field welding will be inspected visually by AWS certified welding inspectors provided by the Owner. Magnetic particle testing or ultrasonic testing may be used in the inspection if deemed necessary by the welding inspector. Comply with all requests of inspector to correct deficiencies.
- D. All costs for testing and inspection required as a result of defection work, repairs, or retests shall be paid for by the Contractor.

- E. Any material or workmanship which is rejected by the Engineer either at the shop, mill or building must be promptly replaced by the Contractor to the Engineer's entire satisfaction.
- F. The fact that steel work has been accepted at the shop and mill shall not prevent its final rejection at the site, or even after it has been erected, if it is found to be defective in any way.
- G. Any steel work rejected at the site shall be removed by the Contractor from the premises within ten (10) working days from the time the Contractor is notified of the rejection.

3.04 FIELD QUALITY CONTROL

- A. Erection Tolerances: Erect individual pieces so that the deviation from plumb, level and alignment shall not exceed 1:500.

END OF SECTION

SECTION 05 14 00

STRUCTURAL ALUMINUM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work under this Section includes fabrication and erection of structural aluminum, as shown on the Drawings and specified herein.
- B. Related Work:
 - 1. Division 01: General Requirements
 - 2. Section 05 52 00: Aluminum Handrails and Railings.

1.02 QUALITY ASSURANCE

- A. Standards: Unless otherwise specified, all materials, workmanship and practices shall conform to the following Standards:
 - 1. Florida Building Code.
 - 2. Aluminum Construction Manual, Latest Edition, by the Aluminum Association.
- B. Qualifications: Fabrication and erection shall be by a qualified fabricator and erector approved by the Engineer. Preparation of shop drawings shall not begin until the fabricator and erector have been approved.

1.03 SUBMITTALS

- A. Materials and Shop Drawings: Complete shop drawings, including material lists, fabrication and erection drawings shall be submitted for review in conformance with Division 01 – General Requirements and Section 01 33 23 – Submittals. Fabrication shall not be approved until the submission has been approved.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Standard Shapes, Bars & Plates:
 - 1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

2. ASTM B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- B. Standard Threaded Fasteners:
1. Aluminum Bolts Alloy 2024-T4.
 2. Aluminum Nuts Alloy 6063-T6.
- C. Welding Electrodes: 4043 filler metal.
- D. Checkered Plate:
1. All checkered plates shall be aluminum, mill finish, and designed for a live load of 100 pounds per square foot of the gross projected area, with the limits for deflections as specified in Federal Specification RR-G-6610.
 2. Checkered plates shall be standard pattern non-slip plates of minimum 3/8 inch thickness and sizes shown on the Drawings. Stiffener angles (aluminum) shall be provided as required to meet the superimposed live load requirements specified above. All checkered plate sections shall be cut to the dimensions shown on the Drawings. Flush type lifting handles shall be provided for each plate, unless otherwise noted on the Drawings.
 3. Plate shall be 6063-T6 alloy aluminum. Raised lugs shall be diamond shaped and have an angled and opposed pattern.

2.02 FABRICATION

- A. Fabrication shall be in accordance with the specified standards. Splices not indicated on the Drawings will not be permitted.
- B. Surface Treatment: Treatment is required only if indicated on the Drawings. (Engineer coordinates with Designer)

PART 3 - EXECUTION

3.01 ERECTION

- A. Erection shall be in accordance with the specified standards and as indicated on the Drawings.
- B. Welding: Welding on aluminum shall be performed by the Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) process, per the AWS Welding handbook.
- C. Painting: No painting is required.

- D. Where the contact of dissimilar metals may cause electrolysis or where aluminum will contact concrete, mortar or plaster, the contact surface of the metals shall be separated using not less than one (1) coat of zinc chromate primer and one (1) heavy coat of aluminum pigmented asphalt paint on each surface; or where deemed necessary by the Engineer, not less than one (1) course of asphalt saturated cotton fabric cemented to both metals with flashing cement, shall be used. Finished works shall be cleaned and excess cement removed.

END OF SECTION

SECTION 05 50 13

MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all miscellaneous metal complete as shown on the Contract Drawings and as specified herein.

1.02 QUALITY ASSURANCE

- A. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. Aluminum Association (AA)
 - a. AA M31C22A41
 - (1) M31: Mechanical Finish, Fine Satin
 - (2) C22: Finish, Medium Matte
 - (3) A41: Clear Anodic Coating, Class I
 - 2. American Society for Testing and Materials (ASTM)
 - a. ASTM A36 - Standard Specification for Carbon Structural Steel
 - b. ASTM A48 - Standard Specification for Gray Iron Castings
 - c. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - d. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality
 - e. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - f. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

- g. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - h. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes
 - i. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
 - j. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - k. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 - l. ASTM A536 - Standard Specification for Ductile Iron Castings
 - m. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
 - n. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - o. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - p. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
 - q. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
 - r. ASTM F3125 - High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions
3. American Iron and Steel Institute (AISI)
- a. Specification for Structural Steel Buildings

4. American Welding Society (AWS)
 - a. AWS D1.1 - Structural Welding Code Steel
 - b. AWS D1.2 - Structural Welding Code - Aluminum
 5. Federal Specifications
 - a. FS-FF-B-575C - Bolts, Hexagonal and Square
 6. Occupational Safety and Health Administration (OSHA)
 7. Florida Building Code (FBC)
 8. International Building Code (IBC)
 9. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- B. The work of this Section shall be completely coordinated with the work of other Sections and the Contract Drawings. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.
- C. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.
- D. All welding shall be performed by AWS certified welders. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2.

1.02 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01 33 23 - Submittals showing materials of construction and details of installation for:
1. Shop drawings showing sizes, finishes, locations, required hardware, and accessories and details for all fabricated metal work, threaded fasteners, and welds. Indicated welds, both shop and field, by symbols conforming to AWS Standards. Shop drawings for continually furnished items will be waived provided the Contractor submits a letter naming the manufacturer who will furnish these items and provide this manufacturer has on file with the Engineer a certified standard drawing containing in the information specified above and herein which has been approved by the Engineer.
 2. Setting diagrams, erection plans, templates, and directions for the installation of backing plates, anchors, and other items.

3. Catalog descriptions of manufacturers' standard items.
4. Working Drawings and calculations for Contractor design hatches and gratings.
5. Specific instructions for all phases of installation including bolt hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.
6. Samples: submit samples as requested by the Engineer during the course of construction.
7. Design Data:
 - a. Submit signed and sealed calculations or test data by Professional Engineer licensed in the State of Florida demonstrating that the railings will resist the loads specified in the Florida Building Code, latest edition
 - b. Submit manufacturer's load and deflection tables for grating.
8. Test Reports:
 - a. Certified copy of mill test reports on each aluminum proposed for use showing the physical properties and chemical analysis.
9. Certificates:
 - a. Submit certification that the railing system is in compliance with OSHA requirements and the Florida Building Code, latest edition
 - b. Submit certificates that welders have been qualified under AWS, within the previous 12 months, to perform the welds required under this Section.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Identify and match mark, if applicable, all materials, items, and fabrications for installation or field assembly
- B. Wherever practicable, deliver items to the site as complete units, ready for installation with all anchors, hangers, fasteners, and miscellaneous metal items needed for installation included.
- C. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

- D. Provide adequate storage facilities at the site for the protection and storage of all delivered materials. Handle and store in such a manner as to not damage factory finishes.
- E. Repair items which have become damaged or corroded to the satisfaction of the Engineer prior to incorporating them into the work at no additional cost to the Owner.

1.04 PROJECT/SITE REQUIREMENTS

- A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items. Measurements shown in the Contract Drawings or provided in these Project Specification shall be field verified prior to fabrication and final installation of items.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one (1) manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.02 MATERIALS

A.	Unless otherwise noted, materials for miscellaneous metals shall conform to the following standards:	
1.	Structural Steel	ASTM A36
2.	Structural Steel Tubing	ASTM A500, Grade B
3.	Welded and Seamless	ASTM A501 or ASTM A53, Steel Pipe Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work
4.	Steel Sheets	ASTM A366
5.	Gray Iron Castings	ASTM A48, Class 35
6.	Ductile Iron Castings	ASTM A536, Grade 65-45-12

7.	Aluminum Extruded Pipe	ASTM B429, Alloy 6063 T6
8.	Aluminum Extruded Shapes	ASTM B221, Alloy 6061 T6
9.	Aluminum Sheet and Plate	ASTM B209, Alloy 6061 T6
10.	Stainless Steel Plates, Sheets, and Structural Shapes	
	a. Exterior, Submerged or Industrial Use	ASTM A240, Type 316 (Type 316L for welded)
	b. Interior and Architectural Use	ASTM A240, Type 304
11.	Stainless Steel Bolts	ASTM A276, Type 316 Nuts, and Washers
12.	Carbon Steel Bolts and Studs	ASTM A307, Grade A (hot dip galvanized nuts and washers where noted)
13.	High Strength Steel Bolts, Nuts and Washers	ASTM F3125 (mechanically galvanized per ASTM B695, Class 50, where noted)
	a. Elevated Temperature Exposure	Type I
	b. General Application	Type I or Type II
14.	Galvanizing	ASTM A123, Zn w/0.5 percent minimum Ni
15.	Galvanizing, hardware	ASTM A153, Zn w/0.5 percent minimum Ni

2.03 ANCHORS, BOLTS AND FASTENING DEVICES

- A. Anchor bolt material shall be ASTM A307 unless otherwise noted.
- B. Unless otherwise noted, bolts for the connection of carbon steel or iron shall be steel machine bolts; bolts for the connection of galvanized steel or iron shall be galvanized steel or stainless steel machine bolts; and bolts for the connection of aluminum or stainless steel shall be stainless steel machine bolts.
- C. Unless otherwise noted, expansion anchors shall be zinc plated carbon steel wedge type anchors complete with nuts and washers. Type 316 stainless steel, wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are required. When the length or

embedment of the bolt is not noted on the Contract Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-inch behind the concrete reinforcing steel. Expansion anchors shall be Hilti, Kwik-bolt II; ITW Redhead trubolt, or equivalent approved by the Engineer.

- D. Compound masonry expansion anchors shall be lead expansion sleeve type anchors complete with nuts and washers. Anchors shall be precision die-cast zinc alloy with a minimum of two (2) lead alloy expansion sleeves. When the length or embedment of the bolt is not noted on the Contract Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-inch behind the concrete reinforcing steel. Expansion anchors shall be Star Expansion Industries, Star Slugin, or equivalent approved by the Engineer.
- E. Adhesive capsule anchors shall be a two-part stud and capsule chemical resin anchoring system. Capsules shall contain premeasured amounts of polyester or vinyl ester resin, aggregate and a hardener contained in a separate vial within the capsule. Stud assemblies shall consist of an all-thread anchor rod with nut and washer. Adhesive capsule anchors shall be Hilti, HVU Adhesive Anchor; or equivalent approved by the Engineer.
- F. Adhesive anchors, for fastening to hollow concrete block or brick, shall be a three-part stud, screen and chemical dispenser anchoring system. Adhesive cartridges shall contain premeasured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Stud assemblies shall consist of an all-thread anchor rod with nut and washer. Anchors shall be Hilti, HIT C-20 System, or equivalent approved by the Engineer.
- G. Automatic end welded headed anchor studs shall be flux ended studs made from cold drawn steel, ASTM A108 Grades C-1010 through C-1020. Headed anchor studs shall be Nelson, H4L Headed Concrete Anchors, or equivalent approved by the Engineer.
- H. Machine bolts and nuts shall conform to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.
- I. Toggle bolts shall be Hilti, Toggler Bolt or equivalent.

2.04 METAL GRATING

- A. Grating shall have rectangular, 3/16-inch thick, bearing bars spaced 1-3/16-inch on center with cross bars spaced at 4-inch on center. All grating panels shall be banded with a bar the same size as the bearing bars.

1. Grating shall not exceed the fabricator's maximum recommended span, and meet or exceed the following load and deflection criteria for the maximum span length at the opening being covered by the grating.
 - a. The grating shall produce a deflection of 1/360 of the span or less under a uniform live load of 100-psf on the maximum span.
 - b. The grating shall produce a deflection of 1/360 of the span or less under a concentrated live load of 300-lbs applied at the mid point of the maximum span.
 2. Openings 2-inch or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing bars or cross bars shall be welded to the banding bar.
 3. Provide trench grating with symmetrical cross bar arrangement.
 4. Grating clamps, nuts, bolts, washers and other fastening devices for grating and grating supports shall be Type 316 stainless steel. All grating shall be anchored to the supporting system using saddle clips.
- B. Aluminum grating material shall be aluminum alloy 6063-T6 with an anodized finish. Cross bars shall be attached to the bearing bars with interlocked swaged joints. The grating shall be Type BS by Harsco Industrial; Type 19 SG-4 by Ohio Gratings, Inc.; or equivalent.
- C. Metal frames and supports for grating shall be of the same material as the grating unless otherwise shown on the Contract Drawings. Where aluminum supports are used, they shall be fabricated from aluminum alloy 6061-T6.

2.05 RAILINGS

- A. Handrail and railing systems shall comply with the requirements of OSHA and FBC.
- B. Aluminum railing and handrail shall be a welded or mechanically fastened, seamless, extruded aluminum pipe system. Rails shall be 6063-T6 alloy. Posts shall be 6061-T6 alloy. Splice and reinforcing sleeves, brackets, end caps, toeboards, etc, shall be aluminum alloy 6063-T6 or 6061-T6. Cast fittings shall be aluminum alloy No. 214. Railing system fastening hardware shall be Type 304 stainless steel. Aluminum shall have a mill finish. After welding, aluminum shall be anodized. All railing, posts, toeboards and exposed aluminum shall be anodized with an architectural Class I satin finish providing a minimum coating thickness of 0.7 mils and a minimum coating weight of 32 milligrams per square inch in compliance with AA M12C22A41.

- C. Railings shall be 2 rail welded railing systems, as shown on the Contract Drawings, fabricated with 1½-inch nominal diameter pipe. Posts shall be Schedule 80 pipe, minimum and rails and handrail shall be Schedule 40 pipe, minimum. Posts and top rails shall be continuous. Spacing of posts shall not exceed 5-foot on center and shall be uniformly spaced except as otherwise shown on the Contract Drawings. Posts will be required on each side of structure expansion joints. All railing posts shall be vertical.
- D. Welds shall be circumferential welds ground smooth and even to produce a railing that is neat in appearance and structurally sound. Welding methods shall be in conformity with AWS standards for the materials being joined. All rail to post connections shall be coped and fastened by continuous welds. There shall be no burrs, sharp edges or protrusions on any weld on any part of the handrail system. After fabrication, the welds and surrounding area shall be cleaned and hand buffed to blend with the adjacent finish. All mechanical fasteners shall be unobtrusively located in countersunk holes with the top flush with the surface of the rail. Bends in the railing shall be as indicated by the Contract Drawings. No distortion of the circular railing shape will be allowed. Bends and terminal sections shall be made without the use of fittings. Corner bends shall be mitered and welded bends.
- E. Railing shall be assembled in sections as long as practical but shall not be greater than 24-foot 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-inch 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.
- F. The bases or supports for railing posts and handrail shall be the types indicated on the Contract Drawings.
1. Where non-removable railing is set in concrete, the posts shall be placed in 2½-inch diameter formed concrete openings and firmly caulked with a nonsulphur compound, hydraulic cement equivalent to Por-Rok by Minwax Construction Products Division Sterling Drug, Montvale, NJ. Collars shall be placed around the post bases and fastened in place with set screws on the side of the post away from the walkway. Posts shall be placed with the

centerline 4-inch from the edge of the concrete except that posts shall be set at the centerline of concrete curbs.

2. Stainless steel and aluminum railing posts, which may collect condensation, shall have a 3/16-inch drain hole drilled immediately above the concrete encased area, the base flange, or supporting socket on the side away from the walking area. The bottom of the rail post between the drain hole and the bottom of the post shall be filled with an inert material such as a compressed closed cell neoprene rod.
 3. Where handrail is to be fastened to walls, the rails shall be provided with screwed wall flanges fastened to the walls with three 3/8-inch stainless steel flat head machine screws.
- G. Safety gates, for railing openings, shall be fabricated of matching pipe and rail material and configuration. The gates shall be self-closing gates with approved stop, latch and stainless steel closure spring and hinges.
- H. Barrier chains, for railing openings, shall be fabricated of stainless steel chains. Chain shall be 1/4-inch stainless steel links, with eleven links per foot as manufactured by Eastern Chain Works, Inc., NY; Lawrence Metal Products, Inc. or equivalent. Chains shall be fastened to the handrail posts at the elevation of each rail. One (1) end of each chain shall be connected to one (1) post with a 1/4-inch diameter stainless steel eye bolt and the other end shall be connected to the other post by means of a heavy chromium plated bronze swivel eye slide harness snap and a similar eye bolt.
- I. Toeboards shall be provided on all railing adjacent to a drop in elevation of 4-feet or more. Toeboards are not required on the inclined portion of stairway railings or where concrete or steel curbs, 4-inch or more in height, are present. Toeboards shall be 4-inch high channels of the same material as the railing. The channels shall have a minimum thickness of 1/8-inch and have flanges of not less than 3/4-inch nor more than 1 1/2-inch in width. Toeboards shall be positioned with a maximum clearance of 1/4-inch from the floor and fastened to railing posts with 1/4-inch stainless steel U-bolts, with J-bolts at corner posts and with clip angles and two (2) 1/4-inch stainless steel expansion bolts at walls.
- J. All railings shall be properly protected by paper, or by an approved coating or by both against scratching, splashes or mortar, paint, or other defacements during transportation and erection and until adjacent work by other trades has been completed. After protective materials are removed, the surfaces shall be made clean and free from stains, marks, or defects of any kind.

2.06 ACCESS HATCHES

- A. Access hatches shall have single or double leaf doors as indicated by the Contract Drawings. The doors shall be 1/4-in aluminum diamond pattern plate with welded stiffeners, as necessary, to withstand a live load of 100 lbs/sq ft with a maximum deflection of 1/150th of the span. Hatches shall have a 1/4-in aluminum channel frame with a perimeter anchor flange or strap anchors for concrete embedment around the perimeter. Unless otherwise noted on the Contract Drawings, use pivot torsion bars for counterbalance or spring operators for easy operation along with automatic door hold open. Hardware shall be durable and corrosion resistant with Type 316 stainless steel hardware used throughout. Provide removable lock handle. Finish shall be the factory mill finish for aluminum doors and frames with bituminous coating on the exterior of the frames in contact with concrete. Hatches shall be watertight and have a 1-1/2-in drainage coupling to the channel frame. Access hatches shall be Types as indicated on the Contract Drawings by Bilco Company, New Haven, CT or equivalent.

2.07 MISCELLANEOUS ALUMINUM

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosings, and any other miscellaneous aluminum called for on the Contract Drawings and not otherwise specified.
- D. Angle frames for hatches, beams, grates, etc, shall be complete with welded strap anchors attached.
- E. Aluminum diamond plate and floor plate shall have a minimum thickness of 3/8-inch. Frames and supports shall be of aluminum construction. Fastening devices and hardware shall be Type 304 stainless steel. Plates shall have a mill finish.

- F. Stair treads for aluminum stairs shall have abrasive non-slip nosing in accordance with OSHA and other applicable standards.
- G. Aluminum nosing at concrete stairs shall be Wooster Products, Inc.; Alumogrit Treads, Type 116; similar by Barry Pattern & Foundry Co.; or Peterson Company. Furnish with wing type anchors and flat head stainless steel machine screws, 12-inches O.C. Nosing shall also be used at concrete ladder openings. Nosing shall be a single piece for each step extending to within 3-inches at each side of stair or full ladder width. Set nosing flush with stair tread finish at concrete stairs. Furnish treads with heavy duty protective tape cover.
- H. Miscellaneous aluminum items shall have a cleaned and degreased mill finish.

2.08 MISCELLANEOUS STEEL

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, holddown straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel called for on the Contract Drawings and not otherwise specified.
- D. Structural steel angle and channel door frames shall be shop coated with primer. Frames shall be fabricated with not less than three (3) anchors on each jamb.
- E. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Contract Drawings or specified elsewhere. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.
- F. Lintels, relief angles or other steel supporting masonry or embedded in masonry shall be shop coated with primer.

- G. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-inches of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.
- H. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2-oz/sq ft of surface.
- I. Interior Metal Stud Wall Framing;
Minimum 16 gauge metal studs for load bearing walls.
Minimum 20 gauge metal studs for non-load bearing walls.
Minimum 16 gauge metal studs for any exterior framed walls.
- J. All free standing walls must be braced at the top every 6-foot maximum and every 4-feet minimum.
- K. Metal furring shall be fastened maximum of 24-inch O.C. vertically while maintaining 16-inch O.C. spacing.
- L. All framing will maintain 16-inch O.C. spacing.

2.09 MISCELLANEOUS STAINLESS STEEL

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Contract Drawings or otherwise specified.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all items except those to be embedded in concrete which shall be installed under Division 03. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.
- B. Abrasions in the shop primer shall be touched up immediately after erection. Areas left unprimed for welding shall be painted with primer after welding.
- C. Zinc coating which has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damage area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two (2) coats of zinc oxide-zinc dust paint conforming to the requirements of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.
- D. Specialty products shall be installed in accordance with the manufacturer's recommendations.
- E. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.
- F. Install adhesive capsule anchors using manufacture's recommended drive units and adapters and in compliance with the manufacturer's recommendations.
- G. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.
- H. All railings shall be erected to line and plumb.
- I. All steel surfaces that come into contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.
- J. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two (2) coats of aluminum metal and masonry paint to the dissimilar metal.
- K. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.

- L. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.
- M. Between aluminum grating, aluminum stair treads, or aluminum handrail brackets and steel supports, insert ¼-inch thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

END OF SECTION

SECTION 05 51 00

METAL STAIRS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: This section is intended to include shop fabrication of aluminum stairs complete with anchors and brackets, including integral handrails and balusters when applicable.
- B. Related Work Described Elsewhere:
 - 1. Division 01: General Requirements
 - 2. Section 05 12 00: Structural Aluminum
 - 3. Section 05 50 13: Miscellaneous Metal
 - 4. Section 09 96 00: Painting and Coating

1.02 QUALITY ASSURANCE

- A. Standards:
 - 1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 2. Aluminum Association, Designation System for Aluminum Finishes.
 - 3. AWS D1.1 - Structural Welding Code.
 - 4. Florida Building Code, Latest Edition.

1.03 SUBMITTALS

- A. Materials and Shop Drawings:
 - 1. Submit the Shop Drawings in accordance with Division 01 – General Requirements and Section 01 33 23 - Submittals.
 - 2. Indicate construction details, sizes of metal sections, thicknesses of metals, profiles, attachments, dimensions and field joints, method of support from structure, work to be built-in or provided by other Sections and finishes.

3. Samples: Two (2) pieces, each 8 inches square in area, of each type finished material.
4. Indicate welded connections, both shop and field, using standard AWS welding symbols. Indicate net weld lengths.
5. Certificates: Manufacturer's certification that materials meet specification requirements.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Verify dimensions on site prior to shop fabrication.
- B. Fabricate stairs, landings, and component connections to support live loads of minimum 100 pounds per square foot (psf) with deflection of stairs and landings not exceeding 1/360 of span.
- C. Fabricate integral railings and component connections capable of resisting lateral forces as indicated by the Standard Building Code.
- D. Shop assemble sections in largest practical sizes, easily handled through building openings.
- E. Accurately form and fit components and connections. Grind exposed edges and welds smooth and flush.
- F. Accurately form components required for proper anchorage of stairs and landings to each other and to building structure.

2.02 MATERIALS

- A. Steel: See Section 11100. Components:
 1. All bridge components, stairs and railings: Galvanized Steel.
- B. Aluminum: ASTM B221, Alloy 6063, Finish AA-C 22A31. Components:
 1. Stringers: Aluminum.
 2. Headers: Aluminum.
 3. Risers: Aluminum.
 4. Railings: Aluminum.

5. Handrails: Aluminum.

C. All bolts, nuts and washers used to fabricate the stairs will be SST.

2.03 FABRICATION OF OPEN GRATING STAIRS (AND LANDINGS)

A. Fabricate stairs with open risers with treads of open gratings.

B. Treads: Minimum 1/4 inch thick by 1-1/2 inches deep by width of stair.

C. Properly secure treads to stringers, bolt in place.

D. Form stringers of channels. Weld fascial plates of minimum 14-gauge sheet stock across channel toes.

E. Landings same as treads, minimum 1/4-inch thick by 1-1/2-inch deep grating. Reinforce underside of landings with angle T's.

PART 3 - EXECUTION

3.01 ERECTION

A. Erect stairs square, level, plumb and free from distortion or defects detrimental to appearance and performance.

B. Provide necessary anchors, plates, angles, hangers, and struts as required for connecting stairs to the structure. Stair assembly to be securely fastened to structure such that no swaying or other distortion of the assembly will occur.

C. Ensure alignment with adjacent construction. Coordinate with related work to ensure no interruption in installation.

D. Perform necessary cutting and altering for the installation of work of other Sections. Do not perform any other additional cutting without review of the Engineer.

E. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible. Where not hidden, use flush countersunk fastenings, unless indicated otherwise. Make mechanically fastened joints flush hairline butted. Grind welds smooth and flush.

END OF SECTION

SECTION 05 52 00

ALUMINUM HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. This Section includes providing all labor, materials and equipment necessary to fabricate and install aluminum railings and accessories. All handrails shall consist of two (2) horizontal rails.

B. Related Work Described Elsewhere:

1. Division 01: General Requirements
2. Section 05 50 13: Miscellaneous Metal
3. Section 05 14 00: Structural Aluminum

1.02 QUALITY ASSURANCE

A. Standards:

1. Occupational Safety and Health Administration Standards, latest edition.
2. Florida Building Code (design standards may exceed OSHA Design Standards).

1.03 SUBMITTALS

- A. Materials and Shop Drawings:** Shop drawings for aluminum railings and accessories shall be submitted for review in conformance with Division 01 – General Requirements and Section 01 33 23 – Submittals.

1.04 DELIVERY AND STORAGE

- A.** Deliver packaged materials to the site in manufacturer's original, unopened containers. Arrange deliveries to provide sufficient quantities to permit continuity of erecting of any phase of work.
- B.** Store to prevent damage to materials or structure. Cover handrails in protective polyethylene wrap to avoid damage to the anodized finish.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. The aluminum railing shall be equivalent to either one (1) of the following specifications, or an approved equivalent:
 - 1. Aluminum railing equivalent to the system produced by CV pipe rail, CraneVeyor Corporation, South El Monte, California. All rails, posts and formed elbows shall be extruded aluminum tube, alloy 6063-T6. Splice and reinforcing sleeves shall be drawn aluminum tubing alloy 6063-T832. Brackets, end caps, toe boards and other fittings shall be extruded aluminum alloy 6063-T5. Fasteners, where used, shall be per "C-V Pipe Rail" standard details and shall be a Type 300 stainless steel. All exposed aluminum shall be anodized with a clear architectural Class I satin finish. The anodic coating shall be a minimum thickness of 0.7 mil and a minimum coating weight of 32 milligrams per square inch, in accordance with the Aluminum Association Designation AA-M12C22A41. Posts, gates, brackets and other fittings shall be anodized after fabrication. Post and rail diameter shall be as shown on the Drawings.
 - 2. Aluminum railing equivalent to the system produced by C/S Rigid Rail 111, Construction Specialties, Inc., Alumaguard Corp., Denver, Colorado, or equivalent. All rails and posts shall be a special anodizing quality 6063 extruded schedule 40 aluminum pipe with special tolerances to accept machined components. All other aluminum parts shall be fabricated from 6063 or 6061 extruded aluminum. All fittings, except bases, shall be a one piece extrusion machined to final shape. All components shall be attached to the rails and posts by use of stainless steel blind rivets and self-tapping screws. Mounting hardware shall be Type 300 stainless steel. All aluminum railing and components shall receive a 215R1 clear anodize finish, minimum 0.7 mil coating. Post and rail diameter shall be as shown on the Drawings (Engineer coordinate with Designer).
- B. Chains at openings greater than 21 inches between sections of railing will not be allowed. Contractor to provide either a removable section of handrail at these areas or fabricate a hinged gate with locking hasp.
- C. Aluminum kickplates where not specifically called for on the Drawings shall be furnished and installed typically at the edges of all elevated walkways. Kickplates shall be 1/4 inch angle or plate stock (depending on the specific walkway edge detail) meeting OSHA requirements and shall project 4 inches above walkway surface. Kickplates shall not infringe on minimum required walkway width and material must be same as that of the railing construction. Kick plates shall not interfere with the removal of grating panels.

PART 3 - EXECUTION

3.01 FABRICATION

- A. Insofar as possible, fabricated material shall be fitted and shop assembled ready for erection. Welding and equipment shall conform to American Welding Society's Code for Welding in Building Construction, latest edition. All work shall be square, plumb and true, accurately fitted with tight joints and intersections. Exposed work shall be finished smooth with welds ground smooth. The completed work shall conform to both OSHA Standards and the Standard Building Code. (Standard Building Code requires three horizontal rails).

3.02 ERECTION

- A. Installation: Where the contact of dissimilar metals may cause electrolysis and where aluminum will contact concrete, mortar or plaster, the contact surface of the metals shall be separated using not less than one (1) coat of zinc chromate primer and one (1) heavy coat of aluminum pigmented asphalt paint on each surface; or where deemed necessary by the Engineer, not less than one (1) course of asphalt saturated cotton fabric cemented to both metals with flashing cement, shall be used. Finished works shall be cleaned and excess cement, shall be used. Finished works shall be cleaned and excess cement removed. All work shall be adequately anchored in place at proper elevations, planes and locations.

END OF SECTION

SECTION 05 53 00

ALUMINUM GRATING SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all labor, materials, and incidentals required to install the aluminum grating, the structural members supporting the grating and the angles, connections, fastenings and concrete inserts attached to or supporting the grating, or those structural members as shown on the Drawings, or specified herein.
- B. Related Work:
 - 1. Division 01: General Requirements
 - 2. Items specified in this Sections which are to be embedded in concrete are to be furnished as part of the work of this Section, but their installation is a part of the work in Division 03 - Concrete.

1.02 STANDARDS

- A. Unless otherwise indicated, all materials, workmanship and practices shall meet all requirements and recommendations of the following standards:
 - 1. Metal Bar Grating Manual - 1974 of the National Association of Architectural Metal Manufacturers.
 - 2. Aluminum Construction Manual, Section 3, third edition 1975 of the Aluminum Association.

1.03 SUBMITTALS

- A. Complete fabrication and erection drawings showing all components of the aluminum grating system shall be submitted for review in conformance with Division 01 – General Requirements and Section 01 33 23 - Submittals. Fabrication shall not begin until Engineer's review is complete.

PART 2 - PRODUCTS

2.01 ALUMINUM GRATING

- A. Configuration: Grating shall be pressure locked aluminum having I shaped bearing bars spaced at 1-3/16 inches on centers and sized as indicated on the

Drawings. Cross bars shall be spaced at 4 inches on centers. All grating surfaces shall be "slip-resistant" serrated type.

- B. Material: Bearing bars shall be of extruded aluminum meeting all requirements of ASTM B-221-76, alloy 6061-T6 or 6063-T6. Cross bars shall be drawn or extruded aluminum meeting all requirements of ASTM B-210-76 or B-221-76.
- C. Anchors shall be galvanized steel saddle clips.
- D. Fabrication shall meet all requirements of the NAAMM Metal Bar Grating Manual. Finish shall be mill finish.
- E. Aluminum Grating System shall be designed for a uniform live load of 100 pounds per square foot of gross projected area and a concentrated load of 300 lbs with with deflection not-to-exceed 1/180 of span.

2.02 ALUMINUM SHAPES

- A. Configuration: Shapes shall be as indicated on the Drawings and as detailed in Section 3 of the Aluminum Construction Manual.
- B. Material: Shapes shall meet all requirements of ASTM B-209 or B-308 for alloy 6061 T6.

2.03 ALUMINUM FASTENINGS

- A. Aluminum fasteners shall not be permitted. All connections of aluminum to aluminum shall be stainless steel as required under Paragraph 2.05, herein.

2.04 STAINLESS STEEL SHAPES

- A. Members supporting aluminum grating or members embedded in concrete shall be stainless steel plate AISI Type 304 formed as indicated. Anchor straps shall be stainless steel shop welded to the stainless steel shapes.

2.05 STAINLESS STEEL FASTENINGS

- A. Connections of stainless steel to aluminum or concrete shall be stainless steel bolts of AISI Type 316. Nuts shall be AISI Type 430 stainless steel.

PART 3 - EXECUTION

3.01 FIELD INSPECTION

- A. Prior to beginning installation, a thorough investigation shall be made of the structure to receive the system to insure that the system can be installed to the indicated alignment. Installation shall not be started until that surface is satisfactory.

3.02 INSTALLATION

- A. The aluminum grating system shall be installed as indicated on the Drawings and Shop Drawings.

END OF SECTION

SECTION 07 16 13

CEMENTITIOUS WATERPROOFING

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Concrete Joints and Accessories: Section 03 25 00.

1.02 SUBMITTALS

- A. Product Data: Catalog sheets, specifications, and application instructions for each material specified.
- B. Quality Control Submittals:
 - 1. Test Reports: If requested by the NAU, furnish certified test data issued by an independent testing laboratory, demonstrating that the products submitted comply with the required physical properties.
 - 2. Installers Qualifications Data:
 - a. Submit the names and addresses of 5 previous cementitious waterproofing projects. Include the type and size of each project.
 - b. Submit a letter certifying that the supervisor or foreman and the workers applying the cementitious waterproofing materials have at least 2 years experience in the application of cementitious waterproofing materials.

1.03 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer's Qualifications: The manufacturer shall have qualified technical representatives with the technical expertise to advise the Contractor of application procedures required for coating materials under the particular job conditions.
 - 2. Applicator's Qualifications: The person supervising the Work of this Section and the workers applying the cementitious waterproofing shall have had 2 years of experience in the application of cementitious waterproofing coatings and in addition

shall have worked on 5 cementitious waterproof coating projects of comparable scope and complexity to the work of this project.

B. Field Examples:

1. On actual surfaces designated by the Director's Representative, apply a sample application of the cementitious waterproof coating. Apply coating on at least 100 sq ft of surfaces.
2. Sample application accepted by the Director's Representative will be used as the standard of comparison for the Work.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:

1. Comply with the manufacturer's printed instructions for material storage requirements.

1.05 PROJECT CONDITIONS

A. Do not execute the Work of this Section until required restoration of substrate has been completed.

B. Environmental Requirements:

1. Do not apply materials to surfaces that contain free water or frost.
2. Do not apply materials when temperature is below 40 degrees F or will fall below 40 degrees within 24 hours.

1.06 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's warranty document executed authorized company official. Manufacturer's warranty is in addition to, and not a limitation of other rights NAU may have under the Contract Documents.

1. Warranty Period: 5 years

PART 2 - PRODUCTS

2.01 CEMENTITIOUS MATERIALS

A. The cementitious waterproofing material shall be designed with crystalline waterproofing technology to protect the concrete surface against water

penetration. The material shall be specially formulated to resist corrosion and chemical/acid attack.

- B. The cementitious waterproofing material shall be ANSI/NSF 61 certified for potable water contact.
- C. The cementitious waterproofing material shall be compatible with the repair material specified under Section 03 93 00.
- D. Cementitious waterproofing system shall be a two coat system such as the “Xypex Concentrate” and “Xypex Modified” by Xypex Chemical Corporation, Richmond, B.C., Canada, or equal.

2.02 Source Quality

- A. Source Quality: Obtain proprietary cementitious waterproofing products from a single manufacturer.

PART 3 - EXECUTION

3.01 MANUFACTURER’S INSTRUCTIONS

- A. Compliance: Comply with manufacturer’s product data, including product technical bulletins, product catalog installation instructions, and product carton instructions.

3.02 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer’s instructions.

3.03 PREPARATION

- A. Surface Preparation: Concrete surfaces to be treated shall be clean and free of laitance, dirt film, paint, coatings or other foreign matter harmful to the performance of proprietary products. Surface shall have an open capillary system to provide tooth and suction for treatment.
- B. Inspection by manufacturer
 - 1. After surface preparation is complete, the Contractor shall schedule an inspection by the manufacturer.
 - 2. The manufacturer shall inspect and certify that the concrete surfaces are in an acceptable condition to receive waterproofing.

3. Such site inspectors shall be scheduled for each waterproofing application.

3.04 APPLICATION

- A. Wetting Concrete: Wet concrete surfaces - saturate - with potable water to enhance the crystalline formation process within concrete. Remove excess surface water before application of Xypex treatment.
- B. Surface Application: Apply treatment uniformly with semi-stiff bristle brush or by spray under conditions and applications rate recommended by manufacturer. Consult with manufacturer for application when spray equipment is used.
 1. First Coat: Apply Xypex Concentrate slurry coat to locations indicated on the Drawings in accordance with the manufacturer's product data.
 2. Second Coat: Apply Xypex Modified slurry coat while first coat of Xypex Concentrate is still "green", but after reaching initial set. Use light, prewatering between coats when rapid drying conditions occur.
- C. Curing: Cure treatment using a misty fog spray of clean water after coating has hardened. Avoid coating damage with spray operation. Spray treated surface three times a day for 2 to 3 days. During curing period, protect, treated surfaces from rainfall, frost and puddling of water. Cure treated concrete surfaces of structures that hold water for three days and allow treatment to set for 12 days before filling with water.
- D. Sequence With Other Work: Comply with crystalline waterproofing manufacturer's recommendations for sequencing construction operations after waterproofing applications. Sequence operations to avoid detrimental performance of waterproofing application.

3.05 FIELD QUALITY REQUIREMENTS

- A. Manufacturer's Field Services: Upon NAU's request, provide manufacturer's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

3.06 PROTECTION

- A. Protection: Protect installed product from damage during construction.

END OF SECTION

SECTION 07 92 13

JOINT SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Caulking and sealants.

1.02 SUBMITTALS

- A. Submit for approval product data, samples, guarantees, and certification of all materials specified, in accordance with Section 01 33 23: Submittals.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be stored and handled so as to prevent the inclusion of foreign matter or the damage of materials by water, heat, sunlight or breaking, and shall be stored in original containers until ready for use. Material showing evidence of damage shall be rejected.

1.04 WARRANTY AND GUARANTEES

- A. Submit a written five (5) year guarantee on sealant type caulking work against joint failure. Joint failure is defined as: leaks of air or water; evidence of loss of adhesion between sealant and joint edge; evidence of loss of cohesion, fading of sealant material; migration of sealant.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. General: Sealants of formulation and qualities indicated that are recommended for applications indicated and that accommodate indicated percentage change in joint width existing at time of installation without failing either adhesively or cohesively.
- B. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- C. Colors: Provide color of exposed joint sealants to comply with the following:
 - 1. Provide selections made by Architect from manufacturer's full range of

standard colors for products of type indicated.

2.02 EXTERIOR BUILDING JOINT SEALANTS

- A. Exterior Building Joints, General: One-part silicone sealant, FS-TT-S-00230C, Type II - non-sag, Class A; color as selected:
1. Elongation Capability $\pm 50\%$
 2. Service Temperature Range -40 to 180°F
 3. Shore A Hardness Range 20 to 35
- B. Glazing Joints - Non-Structural: One-part silicone sealant, FS-TT-S-00230C, Type II, non-sag, Class A; clear:
1. Elongation Capacity $\pm 50\%$
 2. Service Temperature Range -40 to 180°F
 3. Shore A Hardness Range 20 to 35
- C. Embedded Non-Exposed Joints, Sill Members, Splice Covers, Thresholds, Etc.: One-part butyl, polyurethane or polyisobutylene sealant, complying with FS TT-S-1657, Type 1:
1. Elongation Capacity $\pm 5\%$
 2. Service Temperature Range 0 to 180°F
- D. Exposed Horizontal Expansion Joints Subject to Pedestrian and Light Vehicular Traffic: Multi-component polyurethane sealant, self-leveling, traffic grade.
1. Elongation Capacity $\pm 25\%$
 2. Service Temperature Range -40 to 200°F
 3. Shore A Hardness Range 20 to 35
- E. Exposed Horizontal Control Joints Subject to Vehicular and Wheeled Traffic: Multi-component epoxy sealant, pourable, non-primed.
1. Elongation Capacity $\pm 10\%$
 2. Service Temperature Range -40 to 200°F

3. Shore A Hardness Range 70 to 90

2.03 INTERIOR BUILDING JOINT SEALANTS

- A. Interior Building Joints, General: One-part, nonsag, mildew-resistant, paintable sealant of formulation indicated:
1. Solvent-release-curing acrylic terpolymer sealant complying with FS TT-S-00230.
 2. Acrylic-emulsion sealant complying with ASTM C 834 that accommodates joint movement of not more than 5 percent in both extension and compression for a total of 10 percent.
 3. Silicone emulsion sealant complying with ASTM C 834 and, except for weight loss measured per ASTM C 792, with ASTM C 920 that accommodates joint movement of not more than 25 percent in both extension and compression for a total of 50 percent.
 4. Butyl sealant complying with ASTM C 1085 and formulated with minimum of 75 percent solids to be nonstaining, paintable, and have a tack-free time of 24 hours or less.
- B. Acoustical Sealant for Exposed Joints: Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:
1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies per ASTM E 90.
- C. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

2.04 TAPE SEALANTS

- A. Tape Sealant: Solvent-free, butyl-based tape sealant with a solids content of 100 percent formulated to be nonstaining, paintable, and nonmigrating in contact with nonporous surfaces with or without reinforcement thread to prevent stretch and packaged on rolls with a release paper on one side.

PART 3 – EXECUTION

3.01 PREPARATION

A. Joints:

1. All joints shall be thoroughly cleaned; loose particles shall be blown out or vacuumed from joints. Material to be contacted by sealant shall be dry, fully free of laitance, loose aggregate, form release agents, curing compounds, water repellents and other surface treatments.
2. Joint packing shall be installed in all joints to receive sealant where required. Packing shall be sized to require 20 to 50 percent (20% - 50%) compression upon insertion, and shall be placed so that sealant depth is approximately one-half (1/2) joint width. In joints not of sufficient depth to allow packing, polyethylene bondbreaking tape shall be installed at back of joint. Lengthwise stretching of packing materials shall be avoided.
3. Masking tape shall be applied where required to protect adjacent surfaces. Tape shall be adhered in continuous strips in alignment with joint edge and removed immediately after joints have been sealed and tooled.
4. Joints shall be primed where required by sealant manufacturer, to receive sealant in accordance with manufacturer's instructions. Primer shall be brushed uniformly upon all surfaces of joint. Sufficient drying time shall be allowed before caulking.

3.02 APPLICATION

A. Sealant:

1. Mixing and application of sealant shall be as recommended by sealant manufacturer.
2. Material which has exceeded the manufacturer's recommended potential open time (POT Life) shall not be used.
3. Sealant and caulking material shall be applied under pressure to fill joints completely with prevention of air pockets or voids. Tooling shall be performed with solvent recommended by manufacturer. Joints shall be tooled concave.

B. Locations:

1. Sealants shall be applied around penetrations of floor slabs and walls for piping, conduits, ductwork and similar items, at top of slabs and exterior face of walls, around perimeter of door frames and windows, louvers and

vents, and at other locations shown on the Drawings. Thresholds shall be set in full bed of sealant.

- C. Cleaning: Adjacent surfaces shall be cleaned free of sealant and soiling resulting from this work and as work progresses, using solvent or cleaning agent as recommended by the manufacturer. All finished work shall be left in a neat, clean condition. Where any sealant material will permanently stain surfaces, these surfaces shall be masked out to prevent such staining.

END OF SECTION

SECTION 08 33 16

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Electrically operated, overhead, impact resistant, insulated, galvanized steel coiling doors.

1.02 SUBMITTALS

- A. Submit properly identified product data including material specifications and published installation directions and operation and maintenance instructions.
- B. Submit shop drawings for review showing locations, elevations, sizes, materials, gages, construction details, hood, fasteners, seals, counterbalance, manual operators, power operation, finishes, and installation details including power control wiring diagrams.
- C. Submit Laboratory Reports and Products Approval:
 - 1. Hurricane test laboratory reports (including calculations, signed and sealed by State of Florida registered professional engineer) for compliance with Florida Building Code.
 - 2. Dade County Products Control Approval (including approval number).

1.03 QUALITY ASSURANCE

- A. Manufacturer and installer shall have 5 years' experience in overhead coiling door manufacture and successfully completed similar installations.

1.04 CODE COMPLIANCE

- A. The overhead coiling doors indicated in the Architectural drawings and called for in the specifications shall be required to comply with all requirements of the Latest Requirements of the Building Code – Dade County Edition, including Dade County Products Control Approval.
- B. The specified coiling doors or proposed equal products shall comply with the impact and cyclic requirements of the code without the use of shutters. The systems incorporated in the project shall match as closely as possible in elevations, sections and profiles those called for in the Architectural drawings and specifications and still comply with all requirements of the code. Where there is a

discrepancy between the code, and the drawings and specifications, the requirements of the code shall supersede.

- C. The products quoted and supplied for the project shall include all required testing, engineering, product approvals and fees to comply with the codes as required.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. Provide products by ARD (800) DIAL-ARD; Atlas Roll-Lite (407) 857-0680; Cornell Iron Works (800) 233-8366, or approved equal.

2.02 OVERHEAD COILING DOORS

- A. Electrically operated, automatic closing type, with emergency manually operated hand crank, approximate sizes as indicated complete with curtains, guides, roller shafts, brackets, hoods, motor operating devices, anchorage and fastening devices, counterbalance mechanisms, automatic closing devices, governors, hoods, and all other parts and fittings required for a complete installation.

- 1. Dimensions: 10' W x 10' H.

2.03 AUTOMATIC CLOSING DEVICE

- A. Auxiliary spring mounted in spring barrel designed to force door to a closed position when thermally actuated by a fusible link connected to building fire alarm system.

2.04 TIME DELAY RELEASE DEVICE

- A. UL approved time delay release device for each door, for connection with fire alarm systems to prevent false drops due to momentary blackouts or fire alarm tests. Equipment voltage characteristics shall be same as alarm system voltage provided.

2.05 GOVERNOR

- A. Automatic escapement-type designed to control speed during automatic operation and be inoperative during normal operation.

2.06 CURTAIN

- A. Fabricate of interlocking, insulated galvanized steel flat face design slats, 7/8 inch minimum depth by 2-5/8 inches width.

- B. End Locks: Provide manufacturer's standard galvanized malleable iron end locks riveted to ends of every slat.
- C. Reinforce each curtain with a bottom bar consisting of two steel angles

2.07 JAMB GUIDES

- A. Galvanized structural steel angles or rolled formed angles built to form a slot of sufficient depth to retain curtain in guides.

2.08 COUNTERBALANCE MECHANISM

- A. Steel spring mounted around a steel shaft encased in a spring barrel and connected to curtain with manufacturer's standard barrel rings. Use grease sealed or self-lubricating ball bearings for all rotating members.
- B. Spring Barrel: Fabricate of hot-formed carbon steel or welded or seamless pipe of required diameter and wall thickness to support roll-up curtain without distortion of slats and limit barrel deflection to 0.03 inch per foot maximum, of span under load. Hot-dip galvanize barrel inside and out in accord with ASTM A525.
- C. Springs: Oil-tempered adjustable torsion spring for counterbalancing and provision of sufficient torque to assure easy operation of door from any position.
- D. Tension Rod: Case-hardened steel of adequate size to hold fixed end of springs and carry torsional loads.
- E. Brackets: Manufacturer's standard cast iron or cold-rolled steel plate with groove for curtain and designed to house end of coils.

2.09 HOODS

- A. Fabricate from 24 gage minimum galvanized steel sheet to fit contours of brackets and enclose curtain coil.
- B. Provide intermediate hood supports.

2.10 ELECTRIC OPERATOR

- A. Provide U.L. listed assembly in accord with the following:
 - 1. Motor: Instant reversing; high torque, totally enclosed motor of sufficient horsepower to operate door at approximate rate of 8 to 12 inches per second. Electrical requirements: 120V, single phase, 60 Hz.

2. Limit Switch: Equip motor with geared limit switch as an integral part of the mechanism with accurate settings to control up and down movement by breaking circuit.
3. Control Station: Key operated with position “open”, “close”, “off” panel.
4. Emergency Handcrank Operator: Manufacturers Standard ceiling hook type, with removable pole.
5. Safety Edge: Manufacturer’s standard designed to stop door upon touching an obstruction during closing cycle and reverse door to full open position. Design safety edge to serve as bottom dust strip.

2.11 WIND LOCKS

- A. Provide wind locks to comply with applicable codes and local regulations.

2.12 WEATHERSTIPPING

- A. Provide vinyl weatherstripping extending through guides, or equip doors with safety/wear edge.

2.13 SMOKE SEALS

- A. Provide smoke seals as shown on drawings and as per approved manufacturer’s shop and installation drawings to comply with applicable code requirements.

2.14 MISCELLANEOUS PARTS

- A. Provide all miscellaneous parts and fittings as required including motor and gear system supports for a complete installation.

2.15 FINISH

- A. Remove all oil and grease from metal by suitable solvents and shop phosphate treat all galvanizing. Provide one shop coat of rust inhibitive metal primer to non-bearing parts.
- B. Finish for slats and hoods:
 1. Galvanized Finish: One baked on coat of Custom Color epoxy modified polyester paint.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install overhead coiling doors in accord with manufacturer's published installation directions and reviewed and accepted shop drawings under direct supervision of door manufacturer or his authorized representative.
- B. Adjust to operate smoothly without forcing or binding. Hoods and operating mechanism shall be concealed by hung ceiling.

3.02 OPERATOR AND CONTROLS

- A. Install operator and controls where indicated and adjust for proper operation.

3.03 LUBRICATION AND ADJUSTMENT

- A. Adjust and lubricate door operators and moving parts to provide smooth easy operation.

3.04 CLEANING

- A. Remove all stains and splatters from exposed parts and leave surfaces ready for final approval by Architect.

END OF SECTION

SECTION 09 96 00

PAINTING AND COATING

PART 1 - GENERAL

1.01 SCOPE

- A. This specification defines the methods of surface preparation, coating systems, and methods of application for painting as outlined herein.
- B. The work includes painting/coating and finishing of interior and exterior exposed items above and below grade surfaces, such as structural steel, miscellaneous metals, ceilings, walls, floors, doors, frames, pipe, handrails, posts, fittings, valves, pumps, tanks, equipment, and other work required to be painted/ coated unless otherwise specified herein. The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the specification as stated herein.
- C. The Contractor shall furnish all supervision, labor, tools, materials, equipment, scaffolding or other structures, and supervision required for the transportation, unloading, storage, and application of the paint/coating and associated products covered by this specification.
- D. The Contractor or subcontractor shall be certified and licensed for painting/coating and shall have a minimum of 5 years of experience of similar projects in the State of Florida.
- E. The Contractor shall perform surface preparation and application of the painting/coating strictly as specified herein or recommended by the Painting/Coating Manufacturer or the Manufacturer's Representative for each item as specified herein or elsewhere.
- F. The following items will not be painted/coated:
 - 1. Any code requiring labels, such as Underwriters' Laboratories (UL) and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
 - 2. Any moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts, unless otherwise indicated.
 - 3. Aluminum handrails, walkways, windows, louvers, and grating unless otherwise specified herein or elsewhere.
 - 4. Signs and nameplates.

5. Finish hardware.
 6. Stainless steel angles, tubes, pipe, etc.
 7. Products with polished chrome, aluminum, nickel, or stainless steel finish.
 8. Plastic switch plates and receptacle plates.
 9. Flexible couplings, lubricated bearing surfaces, insulation and metal and plastic pipe interior.
 10. Sprinkler heads.
- G. All work shall be done in strict accordance with this specification, Contract Documents, and the painting package, including manufacturer's printed instructions.
- H. The Contractor will obtain, at its own expense, all permits, licenses and inspections and shall comply with all laws, codes, ordinances, rules, and regulations promulgated by authorities having jurisdiction, which may bear on the work. This compliance will include Federal Public Law 91-596 more commonly known as the "Occupational Safety and Health Act of 1970."
- I. Surfaces to be painted: (Refer to Section 2.12 Coating Systems Schedule for description of surfaces to be painted/coated, preparation, and their specified coating systems and colors).

1.02 DEFINITIONS

- A. Field Painting: Painting of new or rebuilt items at the job site. Field painting shall be the responsibility of the Contractor.
- B. Shop Painting: Painting of new or rebuilt items in the shop prior to delivery to the jobsite.
- C. Abbreviations and Terms:
1. SSPC - Society for Protective Coatings
 2. ASTM - American Society of Testing Materials
 3. NACE - National Association of Corrosion Engineers
 4. NSF - National Sanitation Foundation (Standard 61)
 5. AWWA - American Water Works Associates (AWWA D102-14)

6. ICRI - International Concrete Repair Institute
7. CSP - Concrete Surface Profile (1-9)
8. Exterior - outside, exposed to weather
9. Interior Dry - inside, not subject to immersion service
10. Interior Wet - inside, subject to immersion service

1.03 RESOLUTION OF CONFLICTS

- A. It shall be the responsibility of the Contractor to arrange a meeting prior to the start of painting/coating between the Contractors, the Painting/Coating Manufacturer, whose products are to be used, City, and Engineer. All aspects of surface preparation, application and coating systems as specified herein will be reviewed at this meeting.
- B. Clarification shall be requested promptly from the Engineer when instructions are lacking, conflicts occur in the specification, or the procedure seems improper or inappropriate for any reason.
- C. It shall be the responsibility of the Painting/Coating Manufacturer to have their factory representative meet in person with the Contractor and Engineer a minimum of three (3) times during the job as a consultant on surface preparation, mil thickness of coating and proper application of coating unless meeting is determined to be unnecessary by the Engineer.

1.04 INSPECTION OF SURFACES

- A. Before application of the prime coat and each succeeding coat, all surfaces to be coated shall be subject to inspection by the Engineer. Any defects or deficiencies shall be corrected by the Contractor before application of any subsequent coating.
- B. Samples of surface preparation and of painting systems shall be furnished by the Contractor to be used as a standard throughout the job, unless omitted by the Engineer.
- C. When any appreciable time has elapsed between coatings, previously coated areas shall be carefully inspected by the Painting/Coating Manufacturer or their factory representative, and where, in his opinion, surfaces are damaged or contaminated, they shall be cleaned and recoated at the Contractor's expense. Recoating times of manufacturer's printed instructions shall be adhered to.
- D. Coating thickness shall be determined by the use of a properly calibrated "Mikrotest" "Positest" Coating Thickness Gauge (or equal) for ferrous metal or an OG202 "Tooke" Paint Inspection gauge (or equal) for non-ferrous and cementitious

surfaces. Please note that use of the “tooke” gauge is classified as a destructive test. Thickness testing shall be performed in the presence of the Engineer.

1.05 EQUIPMENT

- A. Effective oil and water separators shall be used in all compressed air lines serving spray painting and sandblasting operations to remove oil or moisture from the air before it is used. Separators shall be placed as far as practical from the compressor.
- B. All equipment for application of the paint and the completion of the work shall be furnished by the Contractor in first-class condition and shall comply with recommendations of the Painting/Coating Manufacturer.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials specified herein are manufactured by the Tnemec Company, Inc. or Carboline Company. These products are specified to establish standards of quality and are approved for use on this project. No alternatives or substitutions will be acceptable.
- B. All coatings to be shop applied must meet the requirements for volatile organic compounds (VOC) of not more than 3.5-lbs/gallon after thinning.
- C. Colors, where not specified, shall match as close as possible to the existing color of the existing facilities or as selected by the City or Engineer.
- D. All coatings in contact with potable water need to be NSF Certified in accordance with NSF Standard 61.

2.02 SURFACE PREPARATION

- A. The surface shall be cleaned as specified for the paint system being used. All cleaning shall be as outlined in the Steel Structures Painting Council’s Surface Preparation Specification, unless otherwise noted. If surfaces are subject to contamination, other than mill scale or normal atmospheric rusting, the surfaces shall be pressure washed, and acid or caustic pH residues neutralized, in addition to the specified surface preparation.
- B. Standards for Surface Preparation:

SSPC-SP1 Chemical and/or Solvent Cleaning
Remove all grease, oil, salt, acid, alkali, dirt, dust, wax, fat, foreign matter, and contaminants, etc. by one of the following methods: steam cleaning, alkaline cleaning, or volatile solvent cleaning.

SSPC-SP2 Hand Tool Cleaning

Removal of loose rust, loose mill scale, and loose paint to a clean sound substrate by hand chipping, scraping, sanding, and wire brushing.

SSPC-SP3 Power Tool Cleaning

Removal of loose rust, loose mill scale, and loose paint to a clean sound substrate by power tool chipping, descaling, sanding, wire brushing, and grinding.

SSPC-SP4 Flame Cleaning

Dehydrating and removal of rust, loose mill scale, and some light mill scale by use of flame, followed by wire brushing.

SSPC-SP5 (NACE-1) White Metal Blast Cleaning

Complete removal of all mill scale, rust, rust scale, previous coating, etc., leaving the surface a uniform gray-white color.

SSPC-SP6 (NACE-3) Commercial Grade Blast Cleaning

Complete removal of all dirt, rust scale, mill scale, foreign matter, and previous coatings, etc., leaving only shadows and/or streaks caused by rust stain and mill scale oxides. At least 66 percent (66%) of each square inch of surface area is to be free of all visible residues, except slight discoloration.

SSPC-SP7 (NACE-4) Brush-Off Blast Cleaning

Removal of rust scale, loose mill scale, loose rust, and loose coatings, leaving tightly bonded mill scale, rust and previous coatings. On concrete surfaces, brush-off blast cleaning shall remove all laitance, form oils, and solid contaminants. Blasting should be performed sufficiently close to the surface so as to open up surface voids, bug holes, air pockets, and other subsurface irregularities, but so as not to expose underlying aggregate.

SSPC-SP8 Pickling

Complete removal of rust and mill scale by acid pickling, duplex pickling or electrolytic pickling (may reduce the resistance of the surface to corrosion, if not to be primed immediately).

SSPC-SP10 (NACE-2) Near-White Blast Cleaning

Removal of all rust scale, mill scale, previous coating, etc., leaving only light stains from rust, mill scale, and small specks of previous coating. At least 95 percent (95%) of each square inch of surface area is to be free of all visible residues and the remainder shall be limited to slight discoloration.

SSPC-SP11 Power Tool Cleaning to Bare Metal

Complete removal of rust, rust scale, mill scale, foreign matter, and previous coatings, etc., to a standard as specified on a Commercial Grade Blast Cleaning (SSPC-SP6, NACE-3) by means of power tools that will provide the proper degree of cleaning and surface profile.

SSPC-SP12 (NACE-2) Surface Preparation by Water Jetting

Surface preparation of steel and other substrates by ultra-high pressure water jetting.

SSPC-SP13 (NACE-6) Surface Preparation of Concrete

Surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems.

SSPC-SP14 (NACE-8) Industrial Blast Cleaning

Surface preparation standards for industrial blast cleaning allowing for traces of tightly adherent mill scale, rust, and coating residues on 10 percent (10%) of the surface.

SSPC-SP15 Commercial Grade Power Tool Cleaning

Commercial grade power tool cleaning a steel surface to produce a 1.0-mil surface profile. This method of cleaning falls between SP3 & SP11.

- C. Visual standards – SSPC-VIS-1 (Swedish SIS OS 5900), “Pictorial Surface Preparation Standards for Painting Steel Surfaces,” and the National Association of Corrosion Engineers, “Blasting Cleaning Visual Standards” NACE No. 1/SSPC-SP 5; NACE No. 2/SSPC-SP 10; NACE No. 3/SSPCSP 6; and NACE No. 4/SSPCSP 7 shall be considered as standards for proper surface preparation.
- D. Visual standards from International Concrete Repair Institute CSP1-9 for degree of roughness and surface profile of concrete.
- E. Oil, grease, soil, dust, etc., deposited on the surface preparation that has been completed shall be removed prior to painting according to SSPC-SP1 Solvent Cleaning.
- F. Weld flux, weld spatter and excessive rust scale shall be removed by Power Tool Cleaning as per SSPC-SP11-87T.
- G. All weld seams, sharp protrusions, and edges shall be ground smooth prior to surface preparation or application of any coatings.
- H. All areas requiring field welding shall be masked off prior to shop coating, unless waived by the Engineer.
- I. All areas which require field touch-up after erection, such as welds, burnbacks, and mechanically damaged areas, shall be cleaned by thorough Power Tool as specified in SSPC-SP11-87T.
- J. Touch-up systems will be same as original specification except that approved manufacturer’s organic zinc-rich shall be used in lieu of inorganic zinc where this system was originally used. Also, strict adherence to the manufacturer’s complete touch-up recommendations shall be followed. Any questions relative to

compatibility of products shall be brought to the City's and Engineer's attention; otherwise, Contractor assumes full responsibility.

2.03 PRETREATMENTS

- A. When specified, the surface shall be pretreated in accordance with the specified pretreatment prior to application of the prime coat of paint.

2.04 STORAGE

- A. Materials shall be delivered to the job site in the original packages with seals unbroken and with legible unmutilated labels attached. Packages shall not be opened until they are inspected by the Engineer and required for use. All painting materials shall be stored in a clean, dry, well-ventilated place, protected from sparks, flame, and direct rays of the sun or from excessive heat. Paint susceptible to damage from low temperatures shall be kept in a heated storage space when necessary. The Contractor shall be solely responsible for the protection of the materials stored by him at the job site. Empty coating cans shall be required to be neatly stacked in an areas designated by the City or Engineer and removed from the job site on a schedule determined by the City or Engineer. City and/or Engineer may request a notarized statement from the Contractor detailing all materials used on the project.

2.05 PREPARATION OF MATERIALS

- A. Mechanical mixers, capable of thoroughly mixing the pigment and vehicle together, shall mix the paint/coating prior to use where required by manufacturer's instructions; thorough hand mixing will be allowed for small amounts up to 1-gallon. Pressure pots shall be equipped with mechanical mixers to keep the pigment in suspension, when required by manufacturer's instructions. Otherwise, intermittent hand mixing shall be done to assure that no separation occurs. All mixing shall be done in accordance with SSPC Volume 1, Chapter 4, "Practical Aspects, Use and Application of Paints" and/or with the manufacturer's recommendations.
- B. Catalysts or thinners shall be as recommended by the manufacturer and shall be added or discarded strictly in accordance with the manufacturer's instruction.

2.06 APPLICATION

- A. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather, unless otherwise allowed by the paint/coating manufacturer. Except as provided below, painting shall not be permitted when the atmospheric temperature is below 50°F, or when freshly painted surfaces may be damaged by rain, fog, dust, or condensation, and/or when it can be anticipated that these conditions will prevail during the drying period.

- B. No coatings shall be applied unless surface temperature is a minimum of 5°F above dew point; temperature must be maintained during curing.
- C. Dew Point: Temperature at which moisture will condense on surface. No coatings should be applied unless surface temperature is a minimum of 5°F above this point. Temperature must be maintained during curing.

Example: If air temperature is 70°F and relative humidity is 65 percent (65%), the dew point is 57°F. No coating should be applied unless surface temperature is 62°F minimum.
- D. Suitable enclosures to permit painting during inclement weather may be used if provisions are made to control atmospheric conditions artificially inside the enclosure, within limits suitable for painting throughout the painting operations.
- E. Field Painting in the immediate vicinity of, or on, energized electrical and rotating equipment, and equipment and/or pipes in service shall not be performed without the approval of the Engineer.
- F. Extreme care shall be exercised in the painting of all operable equipment, such as valves, electric motors, etc., so that the proper functioning of the equipment will not be affected.

DEW POINT CALCULATION CHART
Ambient Air Temperature – Fahrenheit

Relative Humidity	20	30	40	50	60	70	80	90	100	110	120
90%	18	28	37	47	57	67	77	87	97	107	117
85%	17	26	36	45	55	65	76	84	95	103	113
80%	16	25	34	44	54	63	73	82	93	102	110
75%	15	24	33	42	52	62	71	80	91	100	108
70%	13	22	31	40	50	60	68	78	88	96	105
65%	12	20	29	38	47	57	66	76	85	93	103
60%	11	20	27	36	45	55	64	73	83	92	101
55%	9	17	25	34	43	53	61	70	80	89	98
50%	6	15	23	31	40	50	59	67	77	86	94
45%	4	13	21	29	37	47	56	64	73	82	91
40%	1	11	18	26	35	43	52	61	69	78	87
35%	-2	8	16	23	31	40	48	57	65	74	83
30%	-6	4	13	20	28	36	44	52	61	69	77

- G. The Contractor's scaffolding shall be erected, maintained, and dismantled without damage to structures, machinery, equipment or pipe. Drop cloths shall be used where required to protect buildings and equipment. All surfaces required to be clear for visual observations shall be cleaned immediately after paint application.
- H. Painting shall not be performed on insulated pipe within 3-feet of insulation operations or on insulation whose covering and surface coat have not had time to set and dry. Painting shall not be performed on uninsulated pipe within 1-foot of any type of connection until the connection has been made, except as directed by the Engineer.
- I. The prime coat shall be applied immediately following surface preparation and in no case later than the same working day. All paint shall be applied by brushing, paint mitt and roller, conventional spraying, or airless spraying, using equipment approved by the paint/coating manufacturer.
- J. Each coat of paint shall be recoated as per manufacturer's instructions. Paint/coating shall be considered recoatable when an additional coat can be applied without any detrimental film irregularities such as lifting or loss of adhesion.
- K. Surfaces that will be inaccessible after assembly shall receive either the full specified paint system or three shop coats of the specified primer before assembly.
- L. Finish colors shall be in accordance with the City's Direction or match existing colors and shall be factory mixed (i.e., there shall be no tinting by the Contractor).
- M. All edges and weld seams in immersion service shall receive a "stripe coat" (applied by brush) of the 1st coat prior to application of the full 1st coat.
- N. All hairline cracks or patches shall receive "stripe coat" of the 1st coat prior to application of the full 1st coat.
- O. All open seams in the roof area of tanks shall be filled after application of the topcoat with a flexible caulking such as Sika Flex 1A.

2.07 WORKMANSHIP

- A. The Contractor must show proof that all employees associated with this project shall have been employed by the Contractor for a period not less than 6 months.
- B. Painting/coating shall be performed by experienced painters/coaters in accordance with the recommendations of the paint/coating manufacturer. All paint/ coating shall be uniformly applied without sags, runs, spots, or other blemishes. Work, which shows carelessness, lack of skill, or is defective in the opinion of the City or Engineer, shall be corrected at the expense of the Contractor.

- C. The Contractor or subcontractor shall be certified and licensed for painting/coating and shall have a minimum of 5 years of experience of similar projects in the State of Florida.
- D. The Contractor shall guarantee the workmanship of the Work performed and materials will be free from defects or failure of workmanship for a period of 1 year upon completion of the Work.

2.08 APPLICATION OF PAINT

A. Brush and/or Rollers:

1. Top quality, properly styled brushes and rollers shall be used. Rollers with a baked phenohl core shall be utilized.
2. The brushing or rolling shall be done so that a smooth coat as nearly uniform in thickness as possible is obtained. Brush or roller strokes shall be made to smooth the film without leaving deep or detrimental marks.
3. Surfaces not accessible to brushes or rollers may be painted by spray, by dauber or sheepskins, and paint mitt.
4. It may require two (2) coats to achieve the specified dry film thickness if application is by brush and roller.

B. Air, Airless, or Hot Spray:

1. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied and shall be equipped with suitable pressure regulators and gauges.
2. Paint shall be applied in a uniform layer, with a 50 percent (50%) overlap pattern. All runs and sags should be brushed out immediately or the paint shall be removed and the surface resprayed.
3. High build coatings should be applied by a crosshatch method of spray application to ensure proper film thickness of the coating.
4. Areas inaccessible to spray shall be brushed; if also inaccessible to brush, daubs or sheepskins shall be used, as authorized by the manufacturer.
5. Special care shall be taken with thinners and paint temperatures so that paint of the correct formula reaches the receiving surface.
6. Nozzles, tips, etc., shall be of sizes and designs as recommended by the manufacturer of the paint being sprayed.

7. The first coat on concrete surfaces in immersion service should be sprayed and backrolled.

2.09 PROTECTION AND CLEAN-UP

- A. It shall be the responsibility of the Contractor to protect at all times, in areas where painting is being done, floors, materials of other crafts, equipment, vehicles, fixtures, and finished surfaces adjacent to paint/coating work. Cover all electric plates, surface hardware, nameplates, gauge glasses, etc., before start of painting/coating work.
- B. At the option of the Engineer during the course of this project, the Contractor will contain all spent abrasives, old paint chips, paint overspray and debris by means suitable to the Engineer and/or City, including but not limited to, full shrouding of the area.
- C. If shrouding is required, the Contractor must provide a complete design of the intended shroud or cover. Care must be taken not to modify or damage the structure during the use of the shroud. If damage should occur, the Contractor is held responsible for all repairs.
- D. At completion of the work, remove all paint/coating where spilled, splashed, splattered, sprayed or smeared on all surfaces, including glass, light fixtures, hardware, equipment, painted, and unpainted surfaces.
- E. After completion of all painting, the Contractor shall remove from job site all painting/coating equipment, surplus materials, and debris resulting from the Work.
- F. The Contractor is responsible for the removal and proper disposal of all hazardous materials from the jobsite in accordance with Local, State, and Federal requirements as outlined by the USEPA.
- G. A notarized statement shall be presented to the City and Engineer that all hazardous materials have been disposed of properly including but not limited to: name of disposal company, disposal site, listing of hazardous materials, weights of all materials, cost per pound and USEPA registration number.

2.10 TOUCH-UP MATERIALS

- A. The Contractor shall provide at the end of the project at least 1-gallon of each generic topcoat in each color as specified by the Engineer for future touch-up. Two (2) gallons may be required for two (2) component materials.

2.11 ON-SITE INSPECTION

- A. During the course of this project the City and/or Engineer will reserve the option of incorporating the services of a qualified inspection service. The inspection

service will be responsible for assuring the proper execution of this specification by the successful Contractor.

2.12 COATING SYSTEM SCHEDULE

- A. Painting/coating all items specified here in shall be in accordance with the manufacturer's recommendations for surface preparation, painting/coating system and application methods. If the painting/coating surface preparation, painting/coating system, dry film thicknesses (DFTs), and application methods specified herein are in conflict the manufacturer's recommendations, the manufacturer's recommendations shall supersede what is specified herein.

STEEL - STRUCTURAL, TANKS, PIPES, AND EQUIPMENT

B. Exterior Exposure (Non-Immersion)

1. System No. 1074U-1 Zinc/Epoxy/Urethane

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

	<u>DFT-Mils</u>
1 st Coat: 90-97 Tneme-Zinc	2.5 – 3.5
2 nd Coat: N69-Color Hi-Build Epoxoline II	2.0 – 3.0
3 rd Coat: 1074-Endura-Shield UVX	<u>3.0 – 5.0</u>
	7.5 – 11.5
	Minimum 7.5 Mils DFT

NOTE: This system is highly resistant to abrasion, wet conditions, corrosive fumes, and chemical contact. Second coat to be same color or close to finish color.

2. System No. 1074U-2 High Build Urethane For Marginally Cleaned Surfaces or Topcoating Existing Systems.

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning SSPC-SP3 Power Tool Cleaning Feather all edges.

	<u>DFT-Mils</u>
Shop Primer: 135*Chembuild	3.0 – 5.0
Tie Coat: 135*Chembuild	3.0 – 5.0
Topcoat: 1074U-Color Endura-Shield UVX	<u>2.0 – 3.0</u>
	5.0 - 8.0 + SPOTS
	Minimum 6.0 Mils

*Can substitute water-based epoxy Series 27 WB Typoxy @ 4.0 – 5.0 mils DFT.

NOTE: This system can be used over factory finish paint or over non-sandblasted steel and offer the high performance of a urethane coating. A test patch is always recommended to insure proper application.

3. System 700-1 Zinc/Urethane/Fluoropolymer (Long Term Color & Gloss Retention)

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

	<u>DFT-Mils</u>
Primer: 90-97 Tneme-Zinc	2.5 – 3.5
2 nd Coat: 73 Endura-Shield	2.0 – 3.0
3 rd Coat: 700 Hydroflon	<u>2.0 – 3.0</u>
	6.5 – 9.5
	Minimum 8.0 Mils

NOTE: This system offers the added corrosion protection of a zinc rich primer. Series 90-97 Tneme-Zinc is an organic zinc-rich primer that can be used for field touch up of a zinc primer or for touch up of galvanized surfaces that are damaged. You can substitute Series 91-H₂O Hydrozinc for the 90-97. You can substitute Series 701 for the Series 700 if a semi-loss finish is desired.

4. System 700-2 Fluoropolymer Overcoat System For Steel Tanks With Solvent-Based Coatings

Surface Preparation: Pressure Clean 3000-psi. Spot SSPC-SP6 Commercial Blast or SSPC-SP3 Power Tool Cleaning. Feather all edges.

	<u>DFT Mils</u>
Spot Primer: 135 Chembuild	3.0 – 5.0
Barrier Coat: 73 Endura-Shield	2.0 – 3.0
Topcoat: 700 Hydroflon	<u>2.0 – 3.0</u>
	4.0 – 6.0 + Spot

NOTE: You can substitute Series 701 for the Series 700 if a semi-gloss finish is desired.

C. Interior Exposure (Non-Immersion)

1. System No. N69-1 High Solids Epoxy

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

	<u>DFT Mils</u>
1 st Coat: N69-Color Hi-Build Epoxoline II	5.0 – 7.0
2 nd Coat: 1074U-Color Endura Shield	<u>2.0 – 3.0</u>
	7.0 – 10.0
	Minimum 9.0 Mils

NOTE: This coating will provide maximum protection. It offers chemical and corrosion resistance for long-term protection against salt spray, moisture, corrosive fumes, and chemical attack. Series N69 is a polyamidoamine cured epoxy. Primer coat must be touched-up before 2nd coat is applied.

2. System No. N69-6 High Build Epoxy (Over OEM Finishes)

Surface Preparation: Spot SSPC-SP6 Commercial Blast Cleaning or SPC-SP11 Power Tool Cleaning To Bare Metal

	<u>DFT-Mils</u>
1 st Coat: Manufacturer's Standard (or existing coating)	1.0 – 2.0
2 nd Coat: 135* Chembuild	3.0 – 5.0
3 rd Coat: 1074U-Color Endura Shield	<u>2.0 – 3.0</u> 5.0–8.0
	Minimum 7.0 Mils

*Can substitute water-based epoxy Series 27WB Typoxy @ 4.0 – 6.0 mils DFT.

NOTE: This system is to be used over standard manufacturer's primer to offer a high performance epoxy finish. Excellent for areas of rust not able to be completely cleaned.

D. Immersion

1. System No. N69-2 High Solids High Build Epoxy (Non-Potable Water)

Surface Preparation: SSPC-SP10 Near White Blast Cleaning

	<u>DFT-Mils</u>
Stripe Coat: N69-Color Hi-Build Epoxoline II by brush and roller to all weld Seams and plate edges	3.0 – 5.0
1 st Coat: N69-Color Hi-Build Epoxoline II	6.0 – 8.0
2 nd Coat: N69-Color Hi-Build Epoxoline II	<u>6.0 – 8.0</u> 15.0 -21.0 (Excluding stripe coat)
	Minimum 16.0 Mils

NOTE: This system provides maximum protection in immersion service. Scarify the surface before topcoating if the Series N69 has been exterior-exposed for 60 days or longer. If primer coat is damaged, it must be touched-up before 2nd coat is applied.

2. System No. N140 High Solids Epoxy (Potable Water)

Surface Preparation: SSPC-SP10 Near White Blast Cleaning

		<u>DFT-Mils</u>
Stripe Coat:	N140-15BL Pota-Pox Plus (by brush and roller to all weld seams and plate edges)	3.0 – 5.0
1 st Coat:	N140-1255 Pota-Pox Plus (Beige)	6.0 – 8.0
2 nd Coat:	N140-15BL Pota-Pox Plus (Tank White)	<u>6.0 – 8.0</u> 12.0 -16.0 (Excluding stripe coat) Minimum 16.0 Mils

NOTE: Series N140 meets the new requirements of approval for potable water use as established by the National Sanitation Foundation Standard 61.

3. System No. 46-30 Coal Tar-Epoxy (Non-Potable Water)

Surface Preparation: SSPC-SP10 Near White Blast Cleaning

		<u>DFT-Mils</u>
One Coat:	46H-413 Hi-Build Tneme-Tar	16.0 – 20.0

NOTE: May be applied in a two-coat application. Review critical recoat time if utilized.

4. System No. 91-H₂O Zinc/Epoxy (Potable Water)

Surface Preparation: SSPC-SP10 Near White Metal Blast

		<u>DFT-Mils</u>
Caulk:	Seal all open roof seems with a flexible NSF Certified caulking such as Sika-Flex 1A.	
Stripe Coat:	91-H ₂ O Hydrozinc 2000 (by brush & roller to all weld seams and plate edges.)	2.5 – 3.5
1 st Coat:	1- H ₂ O Hydrozinc 2000	2.5 – 3.5
2 nd Coat:	N140-1255 Pota-Pox Plus (Beige)	4.0 – 6.0
3 rd Coat:	N140-15BL Pota-Pox Plus (Tank White)	<u>4.0 – 6.0</u> 10.5 -15.5 Minimum 12.0 Mils

NOTE: Meets AWWA D102-97 Inside Coating System No.3

5. System 406-1 Elastomeric Polyurethane

Surface Preparation: SSPC-SP10 Near White Metal Blast

		<u>DFT-Mils</u>
Primer:	1 Omnithane	2.5 – 3.5
Topcoat:	406 Elasto-Shield	<u>75 –100</u> 82.5-103.5 Minimum 80 Mils

OVERHEAD METAL DECKING, JOIST

E. Interior Exposure

1. System No. 115-1 Uni-Bond DF

Surface Preparation: Surfaces must be dry, clean, and free of oil, grease, and other contaminants. Allow concrete to cure 28 days. Galvanized metal decking must be scarified.

	<u>DFT-Mils</u>
Coating: 115-Color Uni-Bond DF	2.0 – 4.0

NOTE: This system should be used on ceiling areas where a one-coat system is desired. Can be applied over steel, galvanized, and aluminum decking, joist, beams, conduits, and concrete.

F. Exterior Exposure

1. System No. 27WB Epoxy/DTM Acrylic

Surface Preparation: Pressure clean to remove all dirt, oil, grease, chemicals, and foreign contaminants. Remove loose paint and all rust by hand and power tool cleaning (SSPC-SP 2 & 3). Feather all edges.

	<u>DFT-Mils</u>
Spot Primer: 27WB Typoxy	3.0 – 5.0
1 st Coat: 30 Spra-Saf EN	2.0 – 4.0
2 nd Coat: 30 Spra-Saf EN	<u>2.0 – 4.0</u>
	4.0 – 8.0 (For 2 Coats)

NOTE: This system can be applied over a wide variety of coatings and factory finishes. It can also be applied direct to galvanized aluminum decking, joists, conduits, and tight rust.

MILL COATED STEEL PIPE

G. Exterior/Interior Exposure (Non-Immersion)

1. System No. N69-3 Epoxy-Polyamide

Surface Preparation: Remove the black mill coating by abrasive blast cleaning per SSPC-SP6. Do not overblast the steel.

	<u>DFT-Mils</u>
1 st Coat: N69-Color Hi-Build Epoxoline II	6.0 – 8.0
2 nd Coat: 1074U Endura-Shield	<u>(2.0 – 3.0)</u>
	8.0–11.0
	Minimum 10.0 Mils

GALVANIZED STEEL – PIPE AND MISCELLANEOUS FABRICATIONS

H. Exterior (Non-Immersion)

1. System No. 1074U-2 Epoxy/High Build Urethane

Surface Preparation: SSPC-SP1 Solvent Cleaning and Scarify by Brush Off Blasting, Hand Sanding, or Chemical Treatment

	<u>DFT-Mils</u>
1 st Coat: N69-Color Hi-Build Epoxoline II	2.0 – 4.0
2 nd Coat: 1074U-Color Endura-Shield	<u>2.0 – 3.0</u>
	4.0 – 7.0
	Minimum 6.0 Mils

NOTE: Series N69 has excellent adhesion to galvanized steel. This system is highly resistant to abrasion, wet conditions, corrosive fumes, and chemical contact. First coat to be same color as or close to the finish color.

I. Interior Exposure (Non-Immersion)

1. System No. N69-6 Polyamide Epoxy

Surface Preparation: SSPC-SP1 Solvent Cleaning and Scarify by Brush Off Blasting, Hand Sanding, or Chemical Treatment.

	<u>DFT-Mils</u>
1 st Coat: N69-Color Hi-Build Epoxoline II	2.0 – 4.0
2 nd Coat: 1074U-Color Endura-Shield	<u>2.0 – 3.0</u>
	4.0 – 7.0
	Minimum 6.0 Mils

J. Immersion (Potable Water)

1. System No. N140-1 Epoxy-Polyamide (Potable Water)

Surface Preparation: Solvent Clean Per SSPC-SP1 & Abrasive Blast per SSPC-SP7

	<u>DFT-Mils</u>
1 st Coat: N140-1255 Pota-Pox Plus Primer	4.0 – 6.0
2 nd Coat: N140-15BL Pota-Pox Plus Finish	<u>4.0 – 6.0</u>
	8.0–12.0
	Minimum 10.0 Mils

NOTE: Series N140 meets the new requirements of approval for potable water use as established by the National Sanitation Foundation Standard 61.

WASTEWATER EQUIPMENT IN IMMERSION SERVICE

K. Steel in Wastewater Immersion

1. System No. 446-1 Perma-Shield MCU

Surface Preparation: SSPC-SP10 (Near White Metal Blast)

	<u>DFT-Mils</u>
Primer: 1 Omnithane	2.5 – 3.5
1 st Topcoat: 446 Perma-Shield MCU	5.0–10.0
2 nd Topcoat: 446 Perma-Shield MCU	<u>5.0–10.0</u>
	12.5 –23.5
	Minimum 15.0 Mils

NOTE: This system offers fast cure for immersion service (4 hours ± @ 75°F). Substitute Series 1074U for 2nd topcoat of Series 446 for areas not in immersion service and exposed to the sun, such as walkways, platforms, handrails, etc.

CONCRETE

L. Exterior - Above Grade

1. System No. 6-1 Acrylic Emulsion

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1st Coat: 6-Color Tneme-Cryl	2.0 – 3.0
2nd Coat: 6-Color Tneme-Cryl	<u>2.0 – 3.0</u>
	4.0 – 6.0
	Minimum 5.0 Mils

NOTE: If semi-gloss finish is desired, use Series 1029 Enduratone as the 2nd coat @ 2.0 – 3.0 mils DFT.

2. System No. 156-1 Modified Acrylic Elastomer

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1st Coat: 156-Color Enviro-Crete	4.0 – 8.0
2nd Coat: 156-Color Enviro-Crete	<u>4.0 – 8.0</u>
	8.0 –16.0
	Minimum 10.0 Mils

NOTE: If texture is needed, use 157 Enviro-Crete TX (medium texture). For application over previously applied coatings, use Tnemec Series 151 Elasto-Grip at 1.0 - 2.5 mils DFT prior to the application of Series 156 Enviro-Crete.

3. System No. 100 Concrete Stain

Surface Preparation: The surface must be clean, dry, sound, free of cracks, and paint.

	<u>SF/Gal/Ct*</u>
Sealer: Chemprobe Prime A Pell H ₂ O	65-200
Concrete Stain: Two (2) coats of Chemprobe Conformal Stain	75-200

*Coverage rates depend on substrate.

M. Exterior - Below Grade

1. System No. 46-31 Coal Tar Epoxy

Surface Preparation: Surface shall be clean and dry. Allow new concrete to cure at least 28 days.

	<u>DFT-Mils</u>
One Coat: 46H-413 Hi-Build Tneme-Tar	14.0-20.0

2. System No. 100-1 Crystalline Waterproofing

Surface Preparation: Surface to be clean and opened up by Brush Blasting, Acid Etching, or Water Blasting w/Turbo Tips. Surface must be pre-wetted prior to application.

1st Coat: XYPEX Concentrate @ (1.5 #/SY)
2nd Coat: XYPEX Modified @ (1.5 #/SY)

NOTE: This system can be applied to concrete that is still wet or hasn't developed final cure. It can be used where wet surface conditions exist or where there is the potential for water intrusion due to hydrostatic pressure. Application shall be per XYPEX specification manual.

N. Interior Exposure (Non-Immersion)

1. System No. 6-1 Acrylic Emulsion (Interior/Exterior)

Surface Preparation: Surface shall be clean and dry. Allow concrete to cure for 28 days.

	<u>DFT-Mils</u>
1 st Coat: 6-Color Tneme-Cryl	2.0 – 3.0
2 nd Coat: 6-Color Tneme-Cryl	2.0 – 3.0
	4.0 – 6.0
	Minimum 5.0 Mils

NOTE: This system will provide a decorative coating with good exterior durability, color retention, and a high vapor transmission rate. For Semi-

Gloss finish, substitute Series 1029 Enduratone for the 2nd coat at 1.5 - 2.0 mils DFT. Apply both the Series 6 & 1029 in the same color.

2. System No. N69-4 Epoxy-Polyamidoamine (Interior)

Surface Preparation: Surfaces shall be clean and dry. Allow concrete to cure for 28 days.

	<u>DFT-Mils</u>
1 st Coat: N69-Color Hi-Build Epoxoline II	4.0 – 6.0
2 nd Coat: N69-Color Hi-Build Epoxoline II	<u>4.0 – 6.0</u>
	8.0 – 12.0
	Minimum 10.0 Mils

3. System No. 113-2 Acrylic Epoxy Semi-Gloss

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 113-Color Tneme-Tufcoat	4.0 – 6.0
2 nd Coat: 113-Color Tneme-Tufcoat	<u>4.0 – 6.0</u>
	8.0 – 12.0
	Minimum 8.0 Mils

NOTE: Substitute Series 114 Tneme-Tufcoat for gloss finish. Multiple coats may be required if application is by roller.

O. Immersion - Potable & Non-Potable Water

1. System No. N69-4 Epoxy-Polyamidoamine (Non-Potable Water)

Surface Preparation: Allow concrete to cure for 28 days. Abrasive blast clean per SSPC-SP13 with a CSP5 or better finish.

	<u>DFT-Mils</u>
Surfacer: 218 MortarClad	1/16"±
1 st Coat: N69-Color Hi-Build Epoxoline II	4.0 – 6.0
2 nd Coat: N69-Color Hi-Build Epoxoline II	<u>4.0 – 6.0</u>
	8.0 – 12.0 + Surfacer
	Minimum 10.0 Mils + Surfacer

NOTE: First coat should be spray applied and backrolled.

2. System No. 104-5 High Solids Epoxy (Non-Potable Water)

Surface Preparation: Allow concrete to cure for 28 days. Abrasive blast clean per SSPC-SP13 with a CSP5 or better finish.

	<u>DFT-Mils</u>
Surfacer: 218 MortarClad	1/16"±
1 st Coat: 104-1255 H.S. Epoxy	6.0 – 10.0

2nd Coat: 104-Color H.S. Epoxy 6.0 – 10.0
12.0 - 20.0 + Surfacer
Minimum 14.0 Mils + Surfacer

NOTE: First coat should be spray applied and backrolled.

3. System No. 46-31 Coal Tar-Epoxy (Non-Potable Water)

Surface Preparation: Allow concrete to cure for 28 days. Abrasive blast clean per SSPC-SP13.

One (1) Coat: 46H-413 Hi-Build Tneme-Tar DFT-Mils
14.0 – 20.0

NOTE: May be applied in a two-coat application. Review critical recoat time if utilized. Surface irregularities and bug holes should be filled to a smooth uniform appearance as required with Tnemec Series 215 Surfacing Coat as required.

4. System No. N140-2 Epoxy-Polyamidoamine (Potable Water)

Surface Preparation: Allow concrete to cure for 28 days. Abrasive blast clean per SSPC-SP13 with a CSP5 or better finish.

Surfacer: 218 MortarClad DFT-Mils
1/16"±
1st Coat: N140-1255 Pota-Pox Plus 6.0 – 8.0
2nd Coat: N140-15BL Pota-Pox Plus 6.0 – 8.0
12.0-16.0 + Surfacer
Minimum 14.0 Mils + Surfacer

NOTE: Series N140 meets the new requirements of approval for potable water use as established by the National Sanitation Foundation Standard 61. Any remaining voids after the 1st coat should be filled as required with Tnemec Series 215 Surfacing Epoxy.

5. System No. 264-1 Elastomeric Polyurethane (Black) (Potable Water)

Surface Preparation: Surfaces shall be clean and dry. Allow new concrete to cure for 28 days. Abrasive blast clean per SSPC-SP13 (Surface Preparation of Concrete) with a CSP5 or better profile.

Surfacer: 218 MortarClad DFT-Mils
1/16"±
Primer: N140-15BL Pota Pox Plus (Tank White) 5.0
Coating: 264 Elasto-Shield 60.0 ±
65.0 Mils + Surfacer

NOTE: This system is NSF Certified for Potable Water. This flexible liner can be used to rehab tanks with leaks. Multiple passes may be required to

achieve the desired thickness that can range from 50-100 mils. See Elasto-Shield Application Guide for detailed instructions. Substitute Series 262 Elasto-Shield for non-potable water applications.

6. System 406-2 (Elastomeric Polyurethane Hybrid)

Surface Preparation: Surfaces shall be clean and dry. Allow new concrete to cure for 28 days. Abrasive blast clean per SSPC-SP13 (Surface Preparation of Concrete) with a CSP5 or better profile.

	<u>DFT-Mils</u>
Surfacer: 218 Mortarclad	1/16"±
Primer: 1 Omnithane	2.5 – 3.5
Topcoat: 406 Elasto-Shield	<u>60 – 75</u>
	60.2-78.5+ Surface
	Minimum 65 Mils

NOTE: This system is NSF Certified for contact with potable water.

P. Interior Exposure (Non-Immersion) Over Existing Coatings

1. System No. 6-1 Acrylic Emulsion

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 6-Color Tneme-Cryl	2.0 – 3.0
2 nd Coat: 6-Color Tneme-Cryl	<u>2.0 – 3.0</u>
	4.0 – 6.0
	Minimum 5.0 Mils

NOTE: If semi-gloss finish is desired, use Series 1029 Enduratone as the 2nd Coat @ 1.5 – 2.0 mils DFT.

2. System No. 113-1 Acrylic-Epoxy Semi-Gloss

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 113-Color Tneme-Tufcoat	2.0 – 3.0
2 nd Coat: 113-Color Tneme-Tufcoat	<u>2.0 – 3.0</u>
	4.0 – 6.0
	Minimum 5.0 Mils

NOTE: This system will provide high performance and can be applied directly over existing coatings without lifting. Can be used when low odor is required during application. Specify Series 114 Tneme-Tufcoat for Gloss Finish. This coating can be spray applied in a single coat at 4.0 - 6.0 mils DFT.

CONCRETE FLOORS

Q. Epoxy Floor Coating

1. System No. 205-1 Epoxy-Polyamide

Surface Preparation: Allow concrete to cure 28 days. Acid Etch or Brush Off Blast Cleaning per SSPC-SP13.

	<u>DFT-Mils</u>
1 st Coat: 205 Terra-Tread FC	3.0 – 5.0
2 nd Coat: 205 Terra-Tread FC	<u>3.0 – 5.0</u>
	6.0–10.0
	Minimum 6.0 Mils

NOTE: This system will provide a durable, longwearing coating that bonds tightly to concrete and stands up under heavy foot traffic, frequent cleaning, and spillage of water, oil, grease, or chemical. For floors exposed to the sun, add a 3rd coat of Tnemec Series 290 CRU at 2.0 - 3.0 mils DFT. For a skid resistant finish broadcast 50 mesh dry washed silica sand into the 1st coat.

2. System No. 287-1 Waterborne Epoxy-Amine

Surface Preparation: Allow concrete to cure 28 days. Acid Etch or Brush Off Blast Cleaning per SSPC-SP13.

	<u>DFT-Mils</u>
1 st Coat: 287-Color Enviro-Pox	2.0 – 4.0
2 nd Coat: 287-Color Enviro-Pox	<u>2.0 – 4.0</u>
	4.0 – 8.0
	Minimum 5.0 Mils

NOTE: For a non-skid finish, add 287-300C skid resistance sand into the first coat. For floors exposed to the sun add a 3rd coat of Tnemec Series 290-CRU at 2.0 – 3.0 mils DFT.

3. System No. 280-1 High Build Polyamine-Epoxy Glaze Floor

Surface Preparation: Allow concrete to cure 28 days. Abrasive Blast Cleaning (Refer to Installation Guide of manufacturer.)

	<u>DFT-Mils</u>
1 st Coat: 201 Epoxoprime	6.0 – 8.0
2 nd Coat: 280 Tneme-Glaze	6.0 – 8.0
3 rd Coat: 280 Tneme-Glaze	<u>6.0 – 8.0</u>
	18.0 - 24.0
	Minimum 18 Mils

NOTE: Please refer to manufacturer's Installation Guide and Technical Data for proper installation. For floors exposed to the sun add a coat of 290 @ 2.0 – 3.0 mils DFT.

4. System No. 237/280 Solid Color Double Broadcast Flooring (Non-Slip)

Surface Preparation: Abrasive Blast Cleaning (Refer to Installation Guide of manufacturer.)

	<u>DFT-Mils</u>
1 st Coat: 237 Power-Tread	1/8" (2 cts. @ 1/16" each)
2 nd Coat: 280 Tneme-Glaze	<u>8.0 – 12.0</u>
	Minimum 1/8"±

NOTE: Please refer to manufacturer's Installation Guide and Technical Data for proper installation. Optional 4th coat of Series 290 CRU at 2.0 - 3.0 mils DFT for floors exposed to the sun.

5. System No. 222/284 Multi-Color Quartz Broadcast Floor and Cove Base

Surface Preparation: Abrasive blast cleaning (Refer to Tnemec Surface Preparation and Installation Guide).

	<u>DFT-Mils</u>
1 st Coat: 222 Deco-Tread	1/8" (2 cts. @ 1/16" each)
2 nd Coat: 84 Deco-Clear	<u>8.0-10.0</u>
	Total 1/8" +

NOTE: Please refer to manufacturer's Installation Guide and Technical Data for proper installation. Optional 4th coat of Series 295 CRU at 2.0 – 3.0 mils DFT for floors exposed to the sun.

POROUS MASONRY (BLOCK)

- R. Exterior/Interior Exposure

1. System No. 6-2 Acrylic Emulsion, Low Sheen

Surface Preparation: Surface shall be clean and dry.

	<u>DFT-Mils</u>
Block Filler: 54 WB Surface Coat	120± SF Gal
1 st Coat: 6-Color Tneme-Cryl	2.0 – 3.0
2 nd Coat: 6-Color Tneme-Cryl	<u>2.0 – 3.0</u>
	*4.0 – 6.0

*Total dry film thickness of topcoats only.

NOTE: For semi-gloss finish, use Series 1029 Enduratone (SG) for the 2nd coat @ 2.0 – 3.0 mils DFT.

2. System No. N69-15 Epoxy-Polyamide (Interior)

Surface Preparation: Surface shall be clean and dry.

Block Filler:	54WB Surface Coat	<u>DFT-Mils</u> 120± SF Gal
1 st Coat:	N69-Color Hi-Build Epoxoline II	4.0 – 6.0
2 nd Coat:	N69-Color Hi-Build Epoxoline II	<u>4.0 – 6.0</u> *8.0–12.0

*Total dry film thickness of topcoats only.

NOTE: Block filler is a water-based epoxy.

3. System No. 104-6 High Solids Epoxy (Interior Only)

Surface Preparation: Surface to be clean and dry.

1 st Coat:	104-Color H.S. Epoxy	<u>DFT-Mils</u> 6.0 – 10.0
2 nd Coat:	104-Color H.S. Epoxy	<u>6.0 – 10.0</u> 12.0 – 20.0
		Minimum 14.0 Mils

NOTE: The surface will be tile-like for easy cleaning and will provide protection against chemical attack, corrosive fumes, high humidity and wash down. Spray and backroll first coat to fill porosity.

4. System No. 113-1 Acrylic-Epoxy Semi-Gloss (Interior Only)

Surface Preparation: Surface must be clean and dry.

Block Filler:	54 WB Surface Coat	<u>DFT-Mils</u> 120± SF Gal
1 st Coat:	113-Color Tneme-Tufcoat	4.0 – 6.0
2 nd Coat:	113-Color Tneme-Tufcoat	<u>4.0 – 6.0</u> 8.0-12.0

NOTE: Series 113 can be spray applied @ 4.0 - 6.0 mils DFT. Application by brush and roller will require additional coats. Series 113 Tneme-Tufcoat has very low odor and can be used when painting in occupied areas. Specify Series 114 Tneme-Tufcoat for a gloss finish.

5. System No. 156-1 Modified Acrylic Elastomer (Exterior)

Surface Preparation: Surface must be clean and dry.

Block Filler:	54 WB Surface Coat	<u>DFT-Mils</u> 120± SF Gal
1 st Coat:	156-Color Enviro-Crete	4.0 – 8.0
2 nd Coat:	156-Color Enviro-Crete	<u>4.0 – 8.0</u> 8.0–16.0
		Minimum 10.0 Mils

(For 2nd & 3rd Coats)

NOTE: If texture is needed, use 157 Enviro-Crete TX (medium texture). For application over previously applied coatings, use TNEMEC 151 Elasto-Grip at 1.0 - 2.5 mils DFT in place of the 54WB Surface Coat.

GYPSUM WALLBOARD

S. Interior Exposure

1. System No. 113-5 Acrylic-Epoxy

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 6 Tnemec-Cryl (Thinned 10%)	1.0 – 2.0
2 nd Coat: 113 H.B. Tneme-Tufcoat	2.0 – 3.0
3 rd Coat: 113 H.B. Tneme-Tufcoat	<u>2.0 – 3.0</u>
	5.0 – 7.0
	Minimum 6.0 Mils

NOTE: Series 113 can be spray applied in a single coat at 4.0 - 6.0 mils DFT. Substitute Series 114 if a gloss finish is desired.

2. System No. N69-22 Hi-Build Epoxoline

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 151 Elasto-Grip	0.7 – 1.5
2 nd Coat: N69-Color Hi-Build Epoxoline II*	<u>4.0 – 6.0</u>
	4.7 - 7.5
	Minimum 5.0 Mils+

NOTE: Two coats may be required if applied by roller.

3. System No. 6-1 Acrylic Emulsion, Low Sheen (Interior Exposure)

Surface Preparation: Surface must be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 6-Color Tneme-Cryl	2.0 – 3.0
2 nd Coat: 6-Color Tneme-Cryl	<u>2.0 – 3.0</u>
	4.0 – 6.0
	Minimum 5.0 Mils

NOTE: This system is designed for mild use areas like office walls, laboratory ceilings, stairwells, etc. For semi-gloss finish, use Series 1029 Enduratone at 2.0 - 3.0 mils DFT for the topcoat.

WOOD

T. Exterior/Interior Exposure

1. System No. 2H-4 Alkyd (Gloss)

Surface Preparation: Surface shall be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 10-99W Tnemec Primer	2.0 – 3.5
2 nd Coat: 2H Hi-Build Tneme-Gloss	1.5 – 3.5
3 rd Coat: 2H Hi-Build Tneme-Gloss	<u>1.5 – 3.5</u>
	5.0–10.5

Minimum 6.0 Mils

2. System No. 6-5 Acrylic Latex (Flat)

Surface Preparation: Surface shall be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 10-99W Tnemec Primer	2.0 – 3.5
2 nd Coat: 6-Color Tneme-Cryl	2.0 – 3.0
3 rd Coat: 6-Color Tneme-Cryl	<u>2.0 – 3.0</u>
	6.0 – 9.5

Minimum 7.5 Mils

NOTE: Substitute Series 1029 Enduratone for the third coat at 1.5 - 2.0 mils DFT if semi-gloss finish is desired.

PVC PIPE

U. Exterior Or Interior

1. System No. 73-23 Epoxy-Polyamide

Surface Preparation: Solvent clean per SSPC-SP1 & Scarify by Brush Blast or Hand Sanding.

	<u>DFT-Mils</u>
1 st Coat: N69-Color Hi-Build Epoxoline II	2.0 – 3.0
2 nd Coat: 1074U Endura-Shield	<u>2.0 – 3.0</u>
	4.0 – 6.0

Minimum 5.0 Mils

INSULATED PIPE

V. Interior Exposure

1. System No. 6-1 Acrylic Emulsion, Low Sheen

Surface Preparation: Surface shall be clean and dry.

	<u>DFT-Mils</u>
1 st Coat: 6-Color Tneme-Cryl	2.0 – 3.0
2 nd Coat: 6-Color Tneme-Cryl	<u>2.0 – 3.0</u>
	4.0 – 6.0
	Minimum 5.0 Mils

NOTE: For semi-gloss finish, use Series 1029 Enduratone for the 2nd coat.

HIGH HEAT COATING

W. Exterior/Interior Exposure

1. System No. 90E-92 Inorganic Zinc (750°F Max)

Surface Preparation: SSPC-SP10 Near White Metal Blast Cleaning

	<u>DFT-Mils</u>
Coating: 90E-02 Tneme-Zinc	2.0 - 3.5

NOTE: Coating will have a greenish gray color but will not require curing at elevated temperatures.

SURFACES EXPOSED TO H₂S/H₂SO₄ (SEVERE EXPOSURE/IMMERSION)

X. Cementitious Surfaces

1. System No. 446-2 Perma-Shield MCU (Concrete)

Surface Preparation: Abrasive blast clean per SSPC-SP13 to remove all laitance, fines, and contamination with a minimum surface profile of CSP5.

	<u>DFT-Mils</u>
Surfacer: 218 Mortarclad	1/16" - 1/8"*
1 st Coat: 446 Perma-Shield MCU	5.0 – 10.0
2 nd Coat: 446 Perma-Shield MCU	<u>5.0 – 10.0</u>
	10.0 - 20.0 + Surfacer
	Minimum 14.0 Mils + Surfacer

* Surfacer needs to be applied by trowel or sprayed and back trowelled.

2. System 436-1 Perma-Shield FR (Concrete)

Surface Preparation: Abrasive blast clean per SSPC-SP13 to remove all laitance, fines, and contamination with a minimum surface profile of CSP5.

	<u>DFT-Mils</u>
1 st Coat: 218 Mortarclad	1/16" - 1/8"*

2 nd Coat:	436 Perma-Shield FR	<u>60 – 100</u>
		60 – 100 + Surfacer

*First coat to be applied by trowel or sprayed and back trowelled. For severe H₂S exposure apply 436 @ 100-125 mils DFT.

Y. Ferrous Metal Surfaces Exposed

1. System No. 435-2 Perma-Glaze

Surface Preparation: SSPC-SP5 White Metal Blast Cleaning (3.0 Mil Profile)

		<u>DFT-Mils</u>
1 st Coat:	435 Perma-Glaze	15.0 – 20.0
2 nd Coat:	435 Perma-Glaze	<u>15.0 – 20.0</u>
		30.0 – 40.0
		Minimum 35.0 Mils

NOTE: Application of a stripe coat to all welds, seams and plate edges is recommended. Can be applied in a single sprayed coat @ 30-40 mils DFT.

PRESTRESSED CONCRETE TANKS

Z. Exterior Exposure

1. System No. 156-3 (New Tanks)

Surface Preparation: Surface to be clean and dry.

		<u>DFT-Mils</u>
1 st Coat:	156-Color Enviro-Crete	4.0 – 6.0
2 nd Coat:	156-Color Enviro-Crete	<u>4.0 – 6.0</u>
		8.0–12.0
		Minimum 10.0 Mils

2. System No. 156-4 Existing Tanks (Previously Painted)

Surface Preparation: Remove all dirt, oil, grease, chalk, and loose paint per High Pressure Water Blast (Min 3500 PSI).

		<u>DFT-Mils</u>
1 st Coat:	151 Elasto-Grip	1.0 – 2.5
Stripe Coat:	Stripe all hairline cracks with a Brushed coat of 156 Enviro-Crete	3.0 – 5.0
Spot Coat:	156 Enviro-Crete	4.0 – 6.0
Topcoat:	156 Enviro-Crete	<u>6.0 – 8.0</u>
		(Cracks) 10.0–15.5
		(Other) 7.0 –10.5

NOTE: 1st coat is optional and can be eliminated with approval from coatings manufacturer. Spot coat of Series 156 for areas of bare concrete.

SECONDARY CONTAINMENT AREAS

AA. Interior

1. System No. 61-4 Epoxy Polyamide (For Fuel Oils)

Surface Preparation: Surface shall be clean and dry. Allow new concrete to cure for 28 days. Abrasive Blast Clean per SSPC-SP13 with a CSP5 or better finish.

	<u>DFT-Mils</u>
Surfacer: 218 MortarClad (Vertical Surfaces)	1/16"
Primer: 61-5002 Tneme-Liner (Beige)	10.0 – 12.0
Topcoat: 61-5001 Tneme-Liner (Gray)	<u>10.0 – 12.0</u>
	20.0 – 24.0
	Minimum 20.0 Mils

NOTE: This system will provide excellent resistance to most chemicals including petrochemicals. Use Tnemec Series 215 Surfacing Epoxy between coats as a filler and surfacer wherever it is required.

2. System 262-1 Flexible Polyurethane

Surface Preparation: Surfaces shall be clean and dry. Allow new concrete to cure for 28 days. Abrasive Blast Clean per SSPC-SP7 (Brush Off Blast).

	<u>DFT-Mils</u>
Surfacer: 218 MortarClad (Vertical Surfaces) 1/16"±	
Primer: N69 Hi-Build Epoxoline II	5.0
Coating: 262 Elasto-Shield (Black)	<u>60.0</u>
	65.0

NOTE: Multiple passes may be required to achieve recommended film thickness. See Elasto-Shield Application Guide for additional instructions. This product is only available in black. Repair all cracks, bugholes, and spalled areas with Series 265 Elasto-Shield TG prior to application of Series 262.

3. System No. 275 Fiber Reinforced Novolac Epoxy (For Acids & Caustics)

Surface Preparation: Allow new concrete to cure 28 days. Abrasive blast clean per SSPC-SP13. Test for moisture and moisture vapor transmission.

	<u>DFT-Mils</u>
Filler Surfacer for Vertical Surfaces: 218 MortarClad	1/16"
Prime Coat: Tnemec Series 201 Epoxoprime*	6.0 – 8.0
Body Coat: Tnemec Series 270 Stranlok	30-35

Topcoat:	applied by spray or trowel Tnemec Series 282 Tneme-Glaze	<u>6.0 – 10.0</u> 42-53

Minimum 20.0 Mils

NOTE: Substitute Koesters VAP 1 2000 if moisture transmission exceeds 3# per 1000 SF in 24 hours for horizontal surfaces.

CLEAR WATER REPELLENT FOR CONCRETE, MASONRY & BRICK

BB.1 Silane/Siloxane Sealer (Water Based)

Surface Preparation: Allow new concrete to cure 28 days. Clean surfaces to be sealed by abrasive blasting or waterblasting.

COATING: BRICK, CONCRETE

Chemprobe PRIME A PELL H ₂ O	125-200 SF/GAL

SPLIT FACED OR POROUS MASONRY

Chemprobe PRIME A PELL H ₂ O	65-100 SF/GAL

BB.2 Silane/Siloxane Sealer w/Concrete Stain

Sealer: Chemprobe Prime A Pell H₂O, 65-200 SF/Gal

Concrete Stain: Two Coats of Chemprobe, 75-200 SF/Gal/Ct Conformal Stain

BB.3 RTV Silicone Rubber Water Repellent And Graffiti Protectorant

1st Coat: 626 Dur A Pell GS 75-300 SF/Gal*

2nd Coat: 626 Dur A Pell GS 75-300 SF/Gal*

NOTE: Depends on substrate. Use 680 Mark A Way for graffiti removal.

MANHOLES, WET WELLS, LIFT STATIONS, AND HEADWORKS AREAS

CC.1 System No. 434-3 Perma-Shield (Epoxy Mortar)

Surface Preparation: Abrasive blast clean per SSPC-SP13 with a CSP5 or better profile.

	<u>DFT-</u> <u>Mils</u>
Surfacer: 218 MortarClad	1/16" - 1/8"
Mortar: 434 Perma-Shield	1/8"
Glaze Coat: 435 Perma-Glaze	<u>15.0 – 20.0</u> 3/16"±

NOTE: Surfer & mortar coats to be applied by trowel or sprayed and back trowelled. All surface voids, cracks, pinholes, and other defects must be filled flush with the adjacent surfaces by putty knife, trowel, float, squeegee, or other suitable method.

CC.2 System No. 100-1 Crystalline Waterproofing

Surface Preparation: Surface to be clean and roughened by Brush Blasting, Acid Etching, or High Pressure Water Blasting (3500 PSI) with turbo tips.

1st Coat: XYPEX Concentrate @ (1.5#/SY) – 1/16"±
2nd Coat: XYPEX Modified @ (1.5#/SY) – 1/16"±

NOTE: This system can be applied to concrete that is still wet or hasn't developed final cure. It can be used where wet surface conditions exist or where there is the potential for water intrusion due to hydrostatic pressure. Where rapid return to service is required use Mega Mix I instead of Modified.

PIPE CROSSINGS AND BACK FLOW PREVENTORS

DD.1 System 700-2 Zinc/Epoxy/Fluoropolymer for New Pipe or Pipe Requiring Removal of Existing Coatings

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

<u>Mils</u>		<u>DFT-</u>
	Primer: 90-97 Tneme-Zinc	2.5 – 3.5
	2nd Coat: 73- Endura-Shield	2.0 – 3.0
	3rd Coat: 700 Hydroflon	<u>2.0 – 3.0</u>
		6.5 – 9.5
		Minimum 8.0
Mils		

NOTE: Substitute Series 701 for a semi-gloss finish.

DD.2 System No. 27WB-2 High Build, High Gloss Urethane for Marginally Cleaned Surfaces or Topcoating Over Existing Systems

Surface Preparation: High Pressure Water Blast (Min 3500 PSI) or Solvent Clean (SSPC-SP1) and Spot Hand and Power Tool Clean (SSPC-SP2 & 3) or Brush Blast (SSPC-SP7). Existing coatings must be clean, dry, and tightly adhering prior to application of coatings.

Mils

DFT-

Spot Primer:	27WB Typoxy	3.0 – 5.0
Tie Coat:	27WB Typoxy	3.0 – 5.0
2nd Coat:	700 Hydroflon	<u>2.0 – 3.0</u>
		5.0 – 8.0

Minimum 6.0

Mils

NOTE: A test Patch is always recommended to insure proper adhesion to existing coatings without lifting of existing coatings. Substitute Series 701 for a semi-gloss finish.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 09 96 50

PIPING, VALVE, AND EQUIPMENT IDENTIFICATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The work included under this Section consists of providing an identification system for piping systems and related equipment in accordance with the Contract Documents and as specified herein.
- B. Related Work Specified Elsewhere:
 - 1. Division 01: General Requirements
 - 2. Section 09 96 00: Painting and Coating

1.02 QUALITY ASSURANCE

- A. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American National Standards Institute (ANSI)
 - a. ANSI A13.1 – Scheme for the Identification of Piping Systems
 - 2. Where reference is made to standards of one (1) of the above, or other originations, the latest edition or version shall apply.

1.03 SUBMITTALS

- A. Submit to the Engineer in accordance with Division 01 – General Requirements and Section 01 33 23 – Submittals.
- B. Submit manufacturer's descriptive literature, illustrations, specifications, and other pertinent data.
- C. Schedules:
 - 1. Provide a typewritten list of all tagged valves giving tag color, shape, letter code and number, the valve size, type, use, and general location.
 - 2. Provide a complete list of materials to be furnished and surfaces on which they will be used.

D. Samples:

1. Provide a sample of each type valve tag supplied.
2. Provide a sample of each type of identification tape supplied.
3. Provide manufacturer's color charts for color selection by Engineer.

1.04 PRODUCTS DELIVERY, STORAGE, AND HANDING

A. Delivery of Materials: Except for locally mixed custom colors, deliver sealed containers with labels legible and intact.

B. Storage of Materials:

1. Store only acceptable project materials on project site.
2. Store in suitable location.
3. Restrict storage to paint materials and related equipment.
4. Comply with health and fire regulations.

1.05 JOB CONDITIONS

A. Environmental Requirements:

1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be applied.
2. Do not apply finish in areas where dust is being generated.

B. Protection: Cover or otherwise protect finished work of other trades and surfaces not to be painted.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials for painting shall conform to requirements of Section 09900 – Painting and Coating.

B. Materials selected for coating systems for each type surface shall be the product of a single manufacturer.

- C. Aboveground piping shall be identified by self-adhesive pipe markers equivalent to those manufactured by Brimar Industries, Inc., Brady Worldwide, Inc., or an approved equal by the Engineer.
1. Markers shall be of wording and color as shown in Table 09905A unless specified elsewhere.
 2. Lettering shall be:
 - a. 2¼-inch high for pipes 3-inch diameter and larger.
 - b. 1⅛-inch high for pipes less than 3-inch diameter.
 3. Flow arrows shall be:
 - a. ¼-inch by 6-inch for pipes 3-inch diameter and larger.
 - b. 1⅛-inch by 3-inch for pipes less than 3-inch diameter.
 4. Color coding for above ground piping shall be in accordance with Section 09 96 00 -Painting and Coating.
- D. Buried piping shall be identified by identification tape installed over the centerline of the pipelines.
1. Identification Tape for Steel or Iron Pipe: Identification tape shall be manufactured of inert polyethylene film so as to be highly resistant to alkalies, acids, or other destructive agents found in soil, and shall have a minimum thickness of 4-mils. Tape width shall be 6-inches and shall have background color specified below, imprinted with black letters. Imprint shall be as specified below and shall repeat itself a minimum of once every 2-feet for entire length of tape. Tape shall be manufactured by Terra Tape, or an approved equal by the Engineer.
 2. Identification Tape for Plastic or Non-Magnetic Pipe: Identification tape shall be manufactured of reinforced polyethylene film with a minimum overall thickness of 4 mils and shall have a 0.35-mil thick magnetic metallic foil core. The tape shall be highly resistant to alkalies, acids, and other destructive agents found in soil. Tape width shall be 3-inch with "Caution" printed with black letters every 21-inches along the entire length of the pipeline. The tape shall have background color as specified in D.4. and D.5., imprinted with black letters. Imprint shall be as specified below and shall repeat itself a minimum of once every 2-feet for entire length of tape. Tape shall be manufactured by TerraTape, or an approved equal by the Engineer.
 3. Detection Wire for Plastic or Non-Magnetic Pipe:

- a. Materials: Continuous, insulated 14-gauge insulated copper wire with the ends sealed with liquid tape. Insulation color shall match the color of the pipe.
- b. Installation: Solid tracer wire must be taped along all pipes. Sections of wire shall be spliced together using Buchanon connectors or a similar approved method for splicing. Twisting the wires together is not acceptable. Contractor to install tracer wire directly above (1-inch maximum) centerline of PVC pipe terminating at top of each valve box and be capable of extending 12-inch above top of box in a manner so as not to interfere with valve operation.

4. Tape background colors and imprints shall be as follows:

<u>Imprint</u>	<u>Background Color</u>
Sewer Line or Force Main	Green
Stormwater Line	Yellow
Electrical Line	Red
Potable Water Line	Dark Blue
Telephone Line	Orange
Concentrate Line	Brown

5. Plant process piping tape background colors and imprints shall be the same as D.4. and as follows:

<u>Imprint</u>	<u>Background Color</u>
Raw Water Line	Olive Green
Clarified Water Line	Aqua
Finished Water Line	Dark Blue
Sodium Hypochlorite	Yellow
Sodium Hydroxide	Yellow
Corrosion Inhibitor	Green
Fluoride	Blue
Alum Solution	Orange
Polymer Solution	Orange
Concentrate Line	Brown

6. Identification tape shall be "Terra Tape" as manufactured by Reef Industries, Inc., Houston, TX or Equal.

- E. Each length shall be clearly labeled so as to allow identification and specification conformance. For potable water pipe identification shall bear National Sanitation Foundation Seal.

- F. Aboveground Valve Identifications: On all valves except shut-off valves located at a fixture or piece of equipment, the Contractor shall provide a coded and numbered tag attached with brass chain and/or brass "S" hooks.
1. Tag types
 - a. Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, air, etc.) shall be brass or anodized aluminum.
 - b. Tags for all other valves shall be color plastic.
 - c. Colors for aluminum and plastic tags shall, where possible, match the color code of the pipe line on which installed.
 - d. Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.
 2. Coding: In addition to the color coding, each tag shall be stamped or engraved with wording or abbreviations to indicate the line service. All color and letter coding shall be approved by the Engineer.
 3. Manufacture: Tags shall be as manufactured by Seton Name Plate Corporation, Floy Tag & Manufacturing Co. or an approved equal by the Engineer.
 4. Valve Schedule: the Contractor shall provide a typewritten list of all tagged valves giving tag color, shape, letter code and number, the valve size, type, use and general location within building.
- G. Buried valves shall have valve boxes protected by a concrete pad. The concrete pad for the valve box cover shall have a 3-inch diameter, bronze disc embedded in the surface as shown on the Contract Drawings. The bronze disc shall have the following information neatly stamped on it:
1. Valve Service - See Table 09905A for abbreviations
 2. Valve Identification No.
 3. Size of valve, inches
 4. Type of valve:
 - a. GV - Gate Valve
 - b. BFV - Butterfly Valve

- c. PV - Plug Valve
- d. CV - Check Valve
- e. BV – Ball Valve

PART 3 - EXECUTION

3.01 COLOR CODING FOR PIPING AND EQUIPMENT

- A. Piping color codes, and code labels for pipe identification shall conform to Table 09905A and Section 09900 - Painting and Coating.
- B. General Notes and Guidelines:
 - 1. Pipelines, equipment, or other items which are not listed here shall be assigned a color by the County and shall be treated as an integral part of the Contract.
 - 2. Color coding shall consist of color code painting and identification of all exposed conduits, through lines and pipelines for the transport of gases, liquids, or semi-liquids including all accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors and any operating accessories which are integral to a whole functional mechanical pipe and electrical conduit systems.
 - 3. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange.
 - 4. All safety equipment shall be painted in accordance with OSHA standards.
 - 5. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to, but not including, the flanges attached to pumps and mechanical equipment assigned another color.
 - 6. All pipe hangers and pipe support floor standards shall be painted, unless specified otherwise due to material of construction.
- C. All hangers and pipe support floor and accessories stands shall be painted to match their piping. The system shall be painted up to, but not including, the face of flanges or the flexible conduit connected to electrical equipment. Structural members used solely for pipe hangers or supports shall be painted to match their piping. Where the contact of dissimilar metals may cause electrolysis and where aluminum will contact concrete, mortar or plaster, the contact surface of the metals shall be coated in accordance with Section 09900 - Painting and Coating.

- D. All systems which are an integral part of the equipment, that is originating from the equipment and returning to the same piece of equipment, shall be painted between and up to, but not including, the face of flanges or connections on the equipment.
- E. All insulated surfaces, unless otherwise specified, shall be given one (1) coat of glue sizing, one (1) prime coat and one (1) finish coat.
- F. System code lettering and arrows shall conform to the requirements of ANSI A 13.1 marked on piping as follows:

- 1. Legends shall be of the following color for the respective pipe color:

<u>Key to Classification of Predominant Colors For Piping</u>		<u>Color of Letters, if not otherwise specified</u>
(F) Fire Protection:	Red	White
(D) Dangerous:	Yellow	Black
	Orange	Black
(S) Safe:	Green	Black
	White	Black
	Black	White
	Light Grey	Black
	Dark Grey	White
	Aluminum	Black
(P) Protective:	Blue	White

- 2. All piping containing or transporting corrosive or hazardous chemicals shall be identified with labels every 10-feet and with at least two (2) labels in each room. Otherwise, markers shall be placed no more than 20-feet apart with at least one marker on every straight run and additional markers at turns and where pipe passes through walls.
- 3. An arrow indicating direction of flow shall be placed adjacent to each marker.

3.02 FABRICATED EQUIPMENT

- A. Unless otherwise indicated or specifically approved, all fabricated equipment shall be shop primed and finished. See Section 09 96 00 – Painting and Coating.
- B. The Contractor shall be responsible for and take whatever steps are necessary to properly protect the shop prime and finish coats against damage from weather or any other cause.

- C. Where specified in other sections of these specifications for mechanical equipment, the Contractor shall apply field coat or coats of paint in accordance with Section 09900 – Painting and Coating. If shop finish coat is unsatisfactory due to poor adhesion or other problems with primer or finish coats, coatings shall be removed and replaced by sandblasting, priming and finishing in accordance with Section 09 96 00 – Painting and Coating and this Section.
- D. Wherever fabricated equipment is required to be sandblasted, the Contractor shall protect all motors, drives, bearings, gears, etc., from the entry of grit. Any equipment found to contain grit shall be promptly and thoroughly cleaned. Equipment contaminated by grit in critical areas, such as bearings, gears, seals, etc., shall be replaced at no cost to the County.

3.03 INSTALLATION OF IDENTIFICATION TAPE

- A. Identification tape shall be installed for all buried wastewater lines in accordance with the manufacturer's installation instructions and as specified herein.
- B. Identification tape for piping shall be installed at two (2) locations:
 - 1. One (1) foot below finished grade along centerline of pipe, and;
 - 2. Directly on top of the pipe.

3.04 BURIED VALVES

- A. In paved or concrete areas, tops of valve box covers shall be set flush with pavement or concrete top. In concrete areas, valve boxes shall be embedded. Following paving operations, a 24-inch square shall be neatly cut in the pavement around the box and the paving removed. The top of the box shall then be adjusted to the proper elevation and a 24-inch square by 6-inch thick concrete pad poured around the box cover. Concrete pads in traffic areas shall be reinforced with No. 4 reinforcement bars as shown on the Contract Drawings. Concrete for the pad shall be 3,000-psi compressive strength.
- B. In unpaved areas, tops of valve box covers shall be set 0.20-foot above finished grade. After the top of the box is set to the proper elevation, a 24-inch square by 6-inch thick concrete pad shall be poured around the box cover. Concrete for the pad shall be 3,000-psi compressive strength.
- C. The bronze, valve identification disc shall be embedded in the concrete pad.

TABLE 09 96 50 A

COLOR CODES AND ABBREVIATIONS

Service	Mark	Conduit, Pipe, and Valve Color Code	Letter and Flow Arrow Color
Raw Water	RW	Olive Green	Black
Permeate	PERM	Aqua	Black
Potable Water	PW	Dark Blue	White
Antiscalant	AS	Orange	Black
Caustic Soda	NaOH	Yellow with Green Band	Black
Chlorine (Solution)	CS	Yellow	Black
Hydrofluosilicic Acid	H ₂ SiF ₆	Light Blue with Red Band	Black
Corrosion Inhibitor	P04	Light Green with Red Band	Black
Nanofiltration Concentrate	NFCNT	Dark Brown	White
Cleaning Solution	CLNC/CLN S	Light Gray	Black
Cleaning Product	CLNP	Light Gray	Black
Nanofiltration Feed Water	NFFW	Olive Green	Black
Pretreated Raw Water	PTRW	Olive Green	Black
Filtered Raw Water	FRW	Olive Green	Black
Finished Water	FW	Dark Blue	White
Force Main	FM	Brown	White
Diesel Fuel	FUEL	OSHA Red	White
Air	AIR	Dark Green	Black

END OF SECTION

SECTION 11 21 40

STAINLESS STEEL VERTICAL MULTISTAGE IN-LINE PUMP

PART I - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install, place in operation, and field test vertical pump, and motor as hereinafter specified, and/or as shown on the Drawings.
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 equipment application. It is, however, intended to cover the furnishing, the shop testing the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.
3. For all units 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. Shop Drawings, Working Drawings and Samples: Section 01 33 23.
2. Start-up: Section 01 91 14.
3. Operating and Maintenance Data: Section 01 78 23.
4. Warranties and Bonds: Section 01 78 36.
5. Painting and Coating: Section 09 96 00.
6. Motors: Section 26 26 50.

C. General Design

1. One (1) pumping unit is required for this Contract. The pump will be of the above stainless steel vertical multi-stage in-line type. The pump will be of the variable frequency drive type. The pumping unit shall be located and arranged as shown on the Drawings. The pump shall start and stop based upon local and remote operator selected control strategies.

2. 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. Qualifications

1. To assure unity of responsibility, the motor shall be furnished and coordinated by the pump manufacturer. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire pumping system including pump, and motor.
2. The pump covered by these Specifications is 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 pump furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pump 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 complete pump with motor shall be manufactured by:
 - a. EBARA
 - b. Goulds
 - c. Or equal

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 Section 01 33 23: Submittals of 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. Long term storage requirements.
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 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 shut off head to pump capacity at minimum specified total head.
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 in addition to those specified in Paragraph 1.05, 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. Long term storage requirements for the motor.
8. Copies of all factory test results, as specified in PART 2 - PRODUCTS of this Section of the Specifications.

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 Section 01 33 23: Submittals.

C. 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. Submit operation and maintenance manuals in accordance with Section 01 78 23. 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 County and the Engineer on proper operation and maintenance. With the County'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 County.

The operation and maintenance manuals shall have been prepared specifically for the model and type of pump furnished and shall not refer to other models and types of similar equipment. The operation and maintenance manuals shall include but not be limited to the following:

1. Equipment function.
2. Description.
3. Normal and limiting operating characteristics.
4. Installation instructions (assembly, alignment and adjustment procedures).
5. Operation instructions (normal start-up and shutdown procedures, normal operating conditions and emergency situations).
6. Lubrication and maintenance instructions.
7. Troubleshooting guide.
8. Parts list with catalog numbers and predicted life of parts subject to wear.
9. Drawings - cross sectional view, assembly and wiring diagrams.
10. Performance curves.

1.04 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 complete.
- B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- C. Finished surfaces of all exposed pump openings shall be protected by wooden blanks.
- 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.
- G. Pump shall be shipped and handled in such manner as to prevent damage. At the job site, pumps and motors shall be stored in clean, dry, and protected locations.

1.05 WARRANTY AND GUARANTEES

- A. All equipment supplied under this section shall be warranted for a period of two (2) years by the manufacturer. Warranty period shall commence upon Owner final acceptance as specified in the General Requirements.
- B. The equipment shall be under warranty to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.
- C. The replacement or repair (including cost of parts and labor) of those items normally consumed in service, such as pump packing, oil, grease, and the like, shall be considered as part of routine preventive maintenance by the Owner.
- D. Certifications: Furnish the Engineer with a written certification signed by the manufacturer's representative, that the installed equipment:
 - 1. Has been installed per manufacturer's requirements.
 - 2. Has been lubricated per manufacturer's instructions.
 - 3. Has been accurately aligned and proper running clearances set.
 - 4. Is free from undue stress imposed by piping or mounting bolts.
 - 5. Is ready to be operated on a continuous basis, and is free from any known defects.
 - 6. Suction piping and seal water piping has been flushed and all debris removed prior to startup.

1.06 TOOLS AND SPARE PARTS

- A. Furnish to the County a complete set of all special tools, including lubricating devices, requires 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) each case gaskets per pump model.
 - 2. Two (2) sets of bearings and wear rings per pump model.
- 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.

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. The discharge head for each pump shall be rigidly and accurately anchored into position. All necessary anchor bolts, nuts and washers shall be as recommended by the pump manufacturer, and provided and installed by the Contractor. Anchor bolts, nuts and washers shall be 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.

2.02 MATERIAL AND EQUIPMENT

- A. General

1. The pump shall be vertical multi-stage, stainless steel pump including a 20-HP, 2-pole, 3-phase, 60 hertz, 460 volt, premium efficiency, vertical, TEFC motor with NEMA 256TC frame size. Motors shall be standard design, commercially available through multiple sources. Rotation shall be clockwise when viewed from the motor.

B. Performance Requirements

1. The pump shall be rated for 150 GPM at 347 ft. TDH, based on a pumped liquid temperature of 68° F, and a specific gravity of 1. The performance curve shall be continuously rising from shut-off to run-out. Wetted components shall be corrosion resistant stainless steel. Pumps shall be NSF61/Annex G (NSF 372) Certified.

C. Pump Construction

1. Materials of Construction:

Impeller	AISI 304SS
Suction Casing	AISI 304SS
Intermediate Casing	AISI 304SS
Discharge Casing	AISI 304SS
Bottom Casing	Cast Iron
Casing Cover	Cast Iron
Outer Casing	AISI 304SS
Shaft	AISI 316SS
Liner Ring	PTFE/AISI 316SS
Motor Bracket	Cast Iron/AISI 304SS
Base	Aluminum Diecast
Upper Thrust Bearing	Sealed Ball Bearing
Lower Pump Bearing	Tungsten Carbide

2. The bottom casings shall be configured with inline ANSI flanged suction discharge connections; the pump suction and discharge shall be the same size:

Suction & Discharge Size	Flange Rating
2-1/2"	300 PSI

3. 3/8" Casing drain taps shall be provided for both the suction and discharge and shall be provided with stainless steel plugs.
4. Tungsten carbide lower pump bearings and sleeves shall be provided to support the rotating assembly from radial thrust loads and maximize operating life.

5. Stainless steel impellers shall be dual shroud, fully enclosed design, secured with a stainless steel locking nut, and positively driven by a stainless steel square-edge spline shaft. Pumps with impellers keyed to the pump shaft are unacceptable and will not be approved. Self-aligning Teflon® coated stainless steel liner rings shall be provided with each stage. Intermediate casings shall be designed to promote smooth flow between stages and to prevent high velocity areas that accelerate erosion.
6. The stainless steel outer pump casing shall allow for thermal expansion in hot water applications and shall be sealed top and bottom with Viton® O-rings. A vent shall be provided to prevent air entrapment.
7. The mechanical seal shall be provided with silicon carbide rotating face, O-ring mounted carbon graphite stationary seat, Viton® elastomers, and 316SS metal parts. The mechanical seal shall be mounted on a stainless steel shaft sleeve. Pumps that require precise measurements associated with mechanical seal installation or placement are unacceptable and will not be approved.
8. The motor support shall incorporate an integral thrust bearing designed for axial and radial thrust loads and to eliminate the need for special motors. Pump designs that subject motor bearings to pump thrust loads are unacceptable and will not be approved. Motors shall be standard design, commercially available through multiple sources.
9. A rigid machined aluminium diecast brass shall be provided to transmit power from the motor shaft to the pump shaft. The pump shaft shall be pinned to eliminate the need to adjust the rotating element for impeller clearance. Pump that requires shims for impeller adjustment and establishment of proper clearances for the rotating element will not be approved.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Installation of pumping equipment shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the Contract Drawings. Equipment shall be installed by experienced and mechanically skilled workmen with previous experience in similar installations. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.
- B. All necessary piping, fittings, valves, air relief valves, vents, concrete foundation, anchor bolts, grouting, etc. shall be provided to insure a complete and satisfactory

installation of the pumping equipment including pump, electric motor, electrical connections and piping connections.

- C. Install pressure gauges on the pump suction and discharge piping as shown on the Drawings, including an isolation valve and pressure gauge at each location.
- D. Hardware: All anchor bolts, nuts and washers shall be Type 316 stainless steel. All brackets and the hardware items shall be Type 316 stainless steel.
- E. Install piping, fittings, valves and other appurtenances to the pump installation in accordance with the manufacturer's installation instructions, the requirements of referenced sections included with these specifications and as shown on the Drawings. Equipment shall be installed in a workmanlike manner so that individual equipment will function properly and freely and no individual parts shall be strained.
- F. Noise and Vibrations: All equipment containing moving parts shall be installed level and plumb, unless otherwise indicated, and shall be anchored securely in order that noise be suppressed to a minimum and that vibrations do not cause damage while in operation.

3.02 FIELD PAINTING

- A. Field surface preparation and painting shall be as specified in Section 09 96 00.

3.03 FACTORY TESTS

- A. Performance Tests:
 - 1. Each pumping unit, complete with the job motor driver or a factory job motor to insure qualify this type pump, shall be subjected to a non-witnessed laboratory performance test. Perform tests in conformance with the applicable provisions of AWWA E102 or the standards of the Hydraulic Institute. To successfully pass a laboratory performance test, a pumping unit shall meet all performance requirements specified.
 - 2. Performance tests shall be "full-scale."
 - 3. Conduct tests preferably at the same minimum submergence that will be realized in the field. The pump performance shall be guaranteed for the actual field conditions.
 - 4. The pressure tap for head measurement shall be located not less than 10 pipe diameters downstream from the discharge elbow of the test pump.
 - 5. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Certified copies of test reports shall be submitted. The Standards of the Hydraulic Institute shall

govern the procedures and calculations for these tests. During these tests, the pumps with drive motors shall be checked for balance.

6. No motor overload above nameplate horsepower shall be allowed.
7. Should results of the full-scale tests indicate, in the opinion of the Engineer, that the pumps shall fail to meet any of the specified requirements, the Engineer shall notify the Contractor of such failure. The manufacturer shall thereupon, at no expense to the City, make such modifications and perform additional tests as may be necessary to comply with these Specifications.

3.04 INSPECTION AND TESTING

- A. After pump has been completely installed, the Contractor shall conduct, in the presence of the Engineer, testing of all mechanical equipment and piping to demonstrate capacity, correct alignment, smooth operation, proper adjustment, and freedom from noise, vibration, over-heating and leaking, and to ensure satisfactory compliance with the specifications. All defects shall be corrected. The Contractor shall supply all oil, grease, electric power, water and all other material necessary to complete the field tests.
- B. If the pump performance does not meet the Specifications, corrective measures shall be taken by the Contractor, or pump shall be removed and replaced with a pump which satisfies the conditions specified.
- C. Motor Field Testing: Motor shall be disconnected from the pump and run for four (4) hours. Following the run-in test, reconnect the motor to the pumping equipment and reinstall all coupling guards.
- D. Pump Field Testing:
 1. After all pumps have been completely installed, and working under the direction of the Manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that the pumping system operates satisfactorily and meets the conditions of service specified. The factory tests are the basis of equipment efficiency demonstration, the field test shall demonstrate correct mechanical operation after pump start-up. Field tests shall include all pumps included under this section. The Contractor shall supply all labor, equipment and incidentals required to complete the field tests.
 2. The equipment manufacturer shall furnish the services of a competent and factory certified 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 one (1) day shall be allocated solely to

the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the County and shall take place prior to plant start-up and acceptance by the County. The final copies of operation and maintenance manuals specified in Section 01 78 23: Operation and Maintenance Data must have been delivered to the Engineer prior to scheduling the instruction period with the County.

3. The Demonstration Test shall demonstrate that all items of these Specifications have been met by the equipment as installed and shall include, but not be limited to, the following tests:
 - a. That all units have been properly installed and are in correct alignment and rotation, using dial indicator for T.I.R. per quote visit and laser aligned for post grout visit.
 - b. That the units operate without overheating or overloading any parts and without exceeding specified limits for objectionable noise and vibration. Test shall include manufacture vibration test at full speed. Sound shall be recorded at full speed. Bearing temperature shall be measured for pump and motor at design condition. Record vibrate A-B, B-C, A-C. Record amperage at design condition L1, L2 and L3 using analog meter if integer study.
 - c. That there are no mechanical defects in any of the parts.
 - d. That the pumps can deliver the specified pressure and quantity ($\pm 5\%$ certified curves).
 - e. That the pumps shall be capable of pumping the specified service liquid.
 - f. That the pump sensors and controls perform satisfactorily and proper alarm functions, if required.
4. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 7-day operating period of the pumps will be required before acceptance.
5. In the event that the equipment does not meet the Demonstration Test, the Contractor shall, at his own expense, make such changes and adjustments in the equipment which he deems necessary and shall conduct further tests until written certification is received from the Engineer.

END OF SECTION

SECTION 11 23 36

HORIZONTAL SPLIT CASE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required and install the pumping units complete with motor, couplings, base and accessories, as shown on the Drawings and as specified herein.
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 equipment application. It is, however, intended to cover the furnishing, the shop testing the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.
3. For all units 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. Shop Drawings, Working Drawings and Samples: Section 01 33 23.
2. Start-up: Section 01 91 14.
3. Operating and Maintenance Data: Section 01 78 23.
4. Warranties and Bonds: Section 01 78 36.
5. Painting and Coating: Section 09 96 00.
6. Motors: Section 26 26 50.

C. General Design:

1. The horizontal split case centrifugal pump design shall include centrifugal pumps, motors, drives, and all appurtenances as shown in the Drawings and specified herein.

2. Seven (7) horizontal split case centrifugal pumps shall be installed as shown on the Drawings. The pumps shall start and stop based upon local and remote operator selected control strategies.
3. 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 County 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. Qualifications

1. To assure unity of responsibility, the motors, cable, and surface plate shall be furnished and coordinated by the pump manufacturer. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire pumping system including pumps and motors.
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, 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.
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 as manufactured by:
 - a. Peerless
 - b. Partterson

c. Or Equal

3. The motors shall be as manufactured by:

a. GE

b. Reliance Electric

c. Westinghouse

d. U.S. Electrical Motors

e. Or Equal

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 Section 01 33 23: Submittals of 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. Long term storage requirements.
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 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 shut off head to pump capacity at minimum specified total head.
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 in addition to those specified in Paragraph 1.05, with the manufacturer's current price for each item. Include gaskets, packing, etc., on the list. List bearings by the manufacturer's numbers only.
7. Complete motor data. Long term storage requirements for the motor.
8. Copies of all factory test results, as specified in PART 2 - PRODUCTS of this Section of the Specifications.

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 Section 01 33 23: Submittals.

- C. 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. Submit operation and maintenance manuals in accordance with Section 01 78 23. 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 County and the Engineer on proper operation and maintenance. With the County'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 County.

The operation and maintenance manuals shall have been prepared specifically for the model and type of pump furnished and shall not refer to other models and types of similar equipment. The operation and maintenance manuals shall include but not be limited to the following:

1. Equipment function.
2. Description.
3. Normal and limiting operating characteristics.
4. Installation instructions (assembly, alignment and adjustment procedures).
5. Operation instructions (normal start-up and shutdown procedures, normal operating conditions and emergency situations).

6. Lubrication and maintenance instructions.
7. Troubleshooting guide.
8. Parts list with catalog numbers and predicted life of parts subject to wear.
9. Drawings - cross sectional view, assembly and wiring diagrams.
10. Performance curves.

1.04 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 complete.
- B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- C. Finished surfaces of all exposed pump openings shall be protected by wooden blanks.
- 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.
- G. Pump shall be shipped and handled in such manner as to prevent damage. At the job site, pumps and motors shall be stored in clean, dry, and protected locations.

1.05 WARRANTY AND GUARANTEES

- A. All equipment supplied under this section shall be warranted for a period of two (2) years by the manufacturer. Warranty period shall commence upon Owner final acceptance as specified in the General Requirements.
- B. The equipment shall be under warranty to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

- C. The replacement or repair (including cost of parts and labor) of those items normally consumed in service, such as pump packing, oil, grease, and the like, shall be considered as part of routine preventive maintenance by the Owner.
- D. Certifications: Furnish the Engineer with a written certification signed by the manufacturer's representative, that the installed equipment:
 - 1. Has been installed per manufacturer's requirements.
 - 2. Has been lubricated per manufacturer's instructions.
 - 3. Has been accurately aligned and proper running clearances set.
 - 4. Is free from undue stress imposed by piping or mounting bolts.
 - 5. Is ready to be operated on a continuous basis, and is free from any known defects.
 - 6. Suction piping and seal water piping has been flushed and all debris removed prior to startup.

1.06 TOOLS AND SPARE PARTS

- A. Furnish to the County a complete set of all special tools, including lubricating devices, requires 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) each case gaskets per pump model.
 - 2. Two (2) sets of bearings and wear rings per pump model.
- 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.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. General:

1. The equipment covered by these Specifications is intended to be standard pumping equipment of proven ability as manufactured by reputable concerns having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practice and methods and shall operate satisfactorily when installed as shown on the Contract Drawings.
2. Equipment shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation and without excessive vibration or strain.
3. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustments.
4. The pump base shall be rigidly and accurately anchored into position, precisely leveled and aligned, so that the completed installation is free from stress or distortion. All necessary foundation bolts, plates, nuts and washers shall be furnished and installed by the Contractor to conform to the recommendations and instructions of the manufacturers. Anchor bolts, nuts and washers shall be Type 316 stainless steel. Grouting under bases after the equipment is set is included as work under this section.
5. Stainless steel nameplate giving the name of manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to the pump.
6. Stainless steel nameplate giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes and all other pertinent data shall be attached to the motor.
7. The nameplate ratings of the motor shall not be exceeded, nor shall the design factor be reduced when its pump is operating at any point on its characteristic curve at maximum speed.

2.02 PUMPS

A. General:

1. The pumps shall be of the single stage and double stage, double suction, horizontal split case design; split on the horizontal axis and shall be bronze fitted construction. Suction and discharge connections shall be located on opposite sides of the lower casing, allowing removal of the rotating element without disturbing the system piping connections.
2. The pumps shall be of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.

3. The pumps shall conform to all requirements stipulated in Table 11 23 36-A.

B. Pump Construction:

1. Pump Casings:

- a. The pump casing material shall be a minimum of class 35 cast iron. Water passageways shall be smooth to permit maximum efficiency. Casing shall be hydrostatically tested at 150% of the maximum working pressure under which the pump could operate at design speed. The suction flange shall be drilled 125 lb. ANSI. The discharge flange shall be drilled 125 lb. ANSI.
- b. Pumps in Table 11 23 36 A that are 150 psi shall be two stage double suction horizontal split case pumps.
- c. The bearing brackets shall be cast as an integral part of the lower casing and have removable bracket caps. The bearing housing shall be doweled for location and anti-rotation. The pump feet shall also be cast as an integral part of the lower casing.
- d. Bronze renewable casing rings shall be furnished, doweled and shouldered in the casing. Ring dowels shall be located in slots on the split surface of the lower casing.

2. Pump Impellers:

- a. The impeller shall be of one piece case bronze, double suction type. The impeller shall be balanced, keyed to the shaft and fixed in an axial position by threaded shaft sleeves. The impeller skirt shall be grooved and fit with close tolerances to the casing ring to permit a minimum of recirculation between the impeller and the casing ring for maximum efficiency.

3. Stuffing Boxes:

- a. Packing - The stuffing boxes shall hold a minimum of five rings of TFE packing. The bronze gland shall be split in two halves, to facilitate removal for repacking. Gland bolts shall be of the swing type made of steel with 18-8 stainless steel nuts.

Or

- b. Mechanical Seal – Sealing of the pump liquid cavity shall be with a face type mechanical seal with ceramic stationary seat, carbon sealing washer, Buna rubber flexible members, stainless steel metal parts and spring. Seal to be rated for 225 °F (107 °C) at 150 psig (10-34 bar)

maximum. Mechanical seals shall be mounted over bronze shaft sleeves.

4. Pump Shaft and Shaft Sleeves:

- a. The shaft shall be carbon steel, adequately sized for the loads transmitted. Shaft deflection shall not exceed 0.002 inches at the face of the stuffing box when operating between 95% and 105% of capacity at best efficiency at the pump's maximum 60 Hz. Speed and with full diameter impeller. The shaft shall be protected through the stuffing box by means of bronze shaft sleeves and they shall be threaded against shaft rotation and locked in place with set screws. The sleeves shall be sealed with "O" rings at the inside diameter to eliminate leakage between the shaft and sleeve.

5. Bearings:

- a. Bearings shall be single row, deep groove ball type; the inboard bearing shall be arranged for radial loads only. The outboard bearing shall be arranged for both radial and axial loads. Both bearings shall be grease lubricated with grease flush through the bearing housing. Bearings shall be designed for an average life of 100,000 hours.
- b. Bearing shall be protected from liquid entry by means of rubber deflectors mounted on the shaft and lip seals in the bearing housings.
- c. Outboard bearing cover shall have a plugged opening for tachometer connection. Bearing housing lubrication design must be capable of being changed from grease to oil lubrication type without replacement of bearing housing or the lower pump casing. The outboard bearing shall have retaining ring retention.

6. Pump Base:

- a. The pump and drive shall be mounted on a common steel base (with optional drip rim). Pump and drive shall be aligned and bolted in place prior to factory shipment. Final alignment must be performed at the jobsite in accordance with the standards of the Hydraulic Institute and the pump installation, operation and maintenance instructions. Base is to be grouted to eliminate vibration. Include grout holes and air release ports for even flow of grout.

7. Coupling:

- a. A flexible coupling shall be provided between the pump and drive. A coupling guard shall be furnished over the coupling for protection. Coupling guards shall be OSHA approved, lockable and manufactured by Faul Orange Peel or engineer approved equal.

2.03 MOTORS

A. General:

1. The motors for the pumps shall be of the horizontal TEFC design.
2. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA Standards where applicable. All motors shall also meet the requirements of Section 26 26 50 Motors

B. Performance Requirements:

1. Motors shall be rated for operation on a 480 volt, three-phase, 60 Hz power supply.
2. Each motor shall have a 1.15 service factor.
3. Motors shall be premium efficiency type.
4. Motors shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level not to exceed 90 dBA as measured 5 feet from any surface.
5. Maximum temperature rise of motor windings shall not exceed 80°C, as measured by resistance, when motor is operated continuously at service factor horsepower, rated voltage and frequency in ambient air temperature of 40°C.
6. Nameplate horsepower shall not be exceeded during pump operation at any point on characteristic curve for impeller furnished.

C. Construction:

1. Motors shall be Corro-Duty suitable for operation in moist air with hydrogen sulfide gas present.
2. Motor frames and end shields shall be of cast-iron construction 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.
3. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibration.
4. The shaft shall be made of high-grade machine steel or steel forgoing of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.

5. Stator and rotor cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be random wound and of size, shape, insulation and number of turns required. Coils shall be epoxy sealed after fabrication.
6. Motors shall be equipped with bearings made of AFBMA Standards, and be of ample capacity of the motor rating. Bearings shall be grease lubricated and shall have a minimum B₁₀ bearing life of 100,000 hours.
7. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all motors. Enclosures shall have stainless steel screen and shall be protected from corrosion, fungus and insects.
8. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.
9. All motors shall be supplied with space heaters to prevent accumulation of moisture. Space heaters shall be rated 120-volt single phase.
10. Motors shall include short commercial factory test.
11. Motors shall include drain and breathers.
12. Motor shall have thermal protection using no or N.C. thermostats.
13. Motor conduit bores to include grounding log and shall be oversized.
14. Motors are all be inverter duty.
15. Motors shall incorporate bearing isolation to protect from any stray currents generated by variable frequency drives.

2.04 CONTROLS: Division 40.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Installation of pumping equipment shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the Contract Drawings. Equipment shall be installed by experienced and mechanically skilled workmen with previous experience in similar installations. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.
- B. All necessary piping, fittings, valves, air relief valves, vents, concrete foundation, anchor bolts, grouting, etc. shall be provided to insure a complete and satisfactory

installation of the pumping equipment including pump, electric motor, electrical connections and piping connections.

- C. Install pressure gauges on the pump suction and discharge piping as shown on the Drawings, including an isolation valve and pressure gauge at each location.
- D. Hardware: All anchor bolts, nuts and washers shall be Type 316 stainless steel. All brackets and the hardware items shall be Type 316 stainless steel.
- E. Install piping, fittings, valves and other appurtenances to the pump installation in accordance with the manufacturer's installation instructions, the requirements of referenced sections included with these specifications and as shown on the Drawings. Equipment shall be installed in a workmanlike manner so that individual equipment will function properly and freely and no individual parts shall be strained.
- F. Noise and Vibrations: All equipment containing moving parts shall be installed level and plumb, unless otherwise indicated, and shall be anchored securely in order that noise be suppressed to a minimum and that vibrations do not cause damage while in operation.

3.02 FIELD PAINTING

- A. Field surface preparation and painting shall be as specified in Section 09 96 00.

3.03 FACTORY TESTS

- A. Performance Tests:
 - 1. Each pumping unit, complete with the job motor driver or a factory job motor to insure qualify this type pump, shall be subjected to a non-witnessed laboratory performance test. Perform tests in conformance with the applicable provisions of AWWA E102 or the standards of the Hydraulic Institute. To successfully pass a laboratory performance test, a pumping unit shall meet all performance requirements specified.
 - 2. Performance tests shall be "full-scale."
 - 3. Conduct tests preferably at the same minimum submergence that will be realized in the field. The pump performance shall be guaranteed for the actual field conditions.
 - 4. The pressure tap for head measurement shall be located not less than 10 pipe diameters downstream from the discharge elbow of the test pump.
 - 5. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Certified copies of test reports shall be submitted. The Standards of the Hydraulic Institute shall

govern the procedures and calculations for these tests. During these tests, the pumps with drive motors shall be checked for balance.

6. No motor overload above nameplate horsepower shall be allowed.
7. Should results of the full-scale tests indicate, in the opinion of the Engineer, that the pumps shall fail to meet any of the specified requirements, the Engineer shall notify the Contractor of such failure. The manufacturer shall thereupon, at no expense to the City, make such modifications and perform additional tests as may be necessary to comply with these Specifications.

3.04 INSPECTION AND TESTING

- A. After pump has been completely installed, the Contractor shall conduct, in the presence of the Engineer, testing of all mechanical equipment and piping to demonstrate capacity, correct alignment, smooth operation, proper adjustment, and freedom from noise, vibration, over-heating and leaking, and to ensure satisfactory compliance with the specifications. All defects shall be corrected. The Contractor shall supply all oil, grease, electric power, water and all other material necessary to complete the field tests.
- B. If the pump performance does not meet the Specifications, corrective measures shall be taken by the Contractor, or pump shall be removed and replaced with a pump which satisfies the conditions specified.
- C. Motor Field Testing: Motor shall be disconnected from the pump and run for four (4) hours. Following the run-in test, reconnect the motor to the pumping equipment and reinstall all coupling guards.
- D. Pump Field Testing:
 1. After all pumps have been completely installed, and working under the direction of the Manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that the pumping system operates satisfactorily and meets the conditions of service specified. The factory tests are the basis of equipment efficiency demonstration, the field test shall demonstrate correct mechanical operation after pump start-up. Field tests shall include all pumps included under this section. The Contractor shall supply all labor, equipment and incidentals required to complete the field tests.
 2. The equipment manufacturer shall furnish the services of a competent and factory certified 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 one (1) day shall be allocated solely to the instruction of plant personnel in operation and maintenance of the

equipment. This instruction period shall be scheduled at least ten days in advance with the County and shall take place prior to plant start-up and acceptance by the County. The final copies of operation and maintenance manuals specified in Section 01 78 23: Operation and Maintenance Data must have been delivered to the Engineer prior to scheduling the instruction period with the County.

3. The Demonstration Test shall demonstrate that all items of these Specifications have been met by the equipment as installed and shall include, but not be limited to, the following tests:
 - a. That all units have been properly installed and are in correct alignment and rotation, using dial indicator for T.I.R. per quote visit and laser aligned for post grout visit.
 - b. That the units operate without overheating or overloading any parts and without exceeding specified limits for objectionable noise and vibration. Test shall include manufacture vibration test at full speed. Sound shall be recorded at full speed. Bearing temperature shall be measured for pump and motor at design condition. Record vibrate A-B, B-C, A-C. Record amperage at design condition L1, L2 and L3 using analog meter if integer study.
 - c. That there are no mechanical defects in any of the parts.
 - d. That the pumps can deliver the specified pressure and quantity ($\pm 5\%$ certified curves).
 - e. That the pumps shall be capable of pumping the specified service liquid.
 - f. That the pump sensors and controls perform satisfactorily and proper alarm functions, if required.
4. If the pump performance does not meet the Specifications, corrective measures shall be taken, or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 7-day operating period of the pumps will be required before acceptance.
5. In the event that the equipment does not meet the Demonstration Test, the Contractor shall, at his own expense, make such changes and adjustments in the equipment which he deems necessary and shall conduct further tests until written certification is received from the Engineer.

**Table 11 23 36-A
Pump Schedule**

Type of Pump	Horizontal Split Case Pump with VFD	Horizontal Split Case Pump with VFD	Horizontal Split Case Pump with VFD	Horizontal Split Case Pump with VFD
No. of units	2	1	1	2
Duty Flow (gpm)	1500	350	350	600
Duty Head (psi)	150	150	70	70
Minimum pump efficiency (%)	80%	60%	60%	70%
Motor to be Supplied (hp)	200	75	75	75
Motor Standard	NEMA	NEMA	NEMA	NEMA
Motor Enclosure/Type	TEFC	TEFC	TEFC	TEFC
Type of Drive	VFD	VFD	VFD	VFD
Suction Size (inches)	6	4	4	4
Discharge Size (inches)	5	3	3	3
Rated Pumping Temperature (°F)	68	68	68	68

END OF SECTION

SECTION 11 31 00

GRINDER PUMP STATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish complete factory-built and tested grinder pump unit(s), each consisting of a grinder pump core suitably mounted on an integral stand of stainless steel, tank, electrical quick disconnect (NEMA 6P), pump removal harness, discharge assembly/shut-off valve, anti-siphon valve/check valve assembly, electrical alarm assembly and all necessary internal wiring and controls. For ease of serviceability, all pump motor/grinder units shall be of like type and horsepower throughout the system.

1.02 SUBMITTALS

- A. Furnish shop drawings detailing the equipment to be furnished including dimensional data and materials of construction in accordance with the provisions of Section 01 33 23: Submittals of these Specifications.

1.03 QUALITY ASSURANCE

- A. Manufacturer: Grinder pump stations, complete with all appurtenances, form an integral system, and as such, shall be supplied by one grinder pump station manufacturer. The Contractor shall be responsible for the satisfactory operation of the entire system. The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The company shall submit detailed installation and user instructions for its product, submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The Manufacturer shall provide, upon request, a reference and contact list from ten of its largest contiguous grinder pump installations of the type of grinder pumps described within this specification. Manufacturer shall be Environment/One, Model WH101 (hard wired level controls) or equal.
- B. Warranty: The grinder pump Manufacturer shall provide a part(s) and labor warranty on the complete station and accessories, including, but not limited to, the panel for a period of 24 months after notice of County's acceptance, but no greater than 27 months after receipt of shipment. Any manufacturing defects found during the warranty period will be reported to the Manufacturer by the County and will be corrected by the Manufacturer at no cost to the County.

- C. Operating Conditions: The pumps shall be capable of delivering 15 GPM against a rated total dynamic head of 0 feet (0 PSIG), 11 GPM against a rated total dynamic head of 92 feet (40 PSIG), and 7.8 GPM against a rated total dynamic head of 185 feet (80 PSIG). The pump(s) must also be capable of operating at negative total dynamic head without overloading the motor(s). Under no conditions shall in-line piping or valving be allowed to create a false apparent head.
- D. Warranty Performance Certification: As a bid certification requirement, each bidder shall provide with their bid schedule a Warranty Performance Certification statement executed by the most senior executive officer of the grinder pump Manufacturer, which certifies a minimum of a 24-month warranty. They must further detail any exclusions from the warranty or additional cost items required to maintain the equipment in warrantable condition, including all associated labor and shipping fees, and certify that the Manufacturer will bear all costs to correct any original equipment deficiency for the effective period of the warranty. All preventive maintenance type requirements shall be included in this form as exclusions. These requirements include, but are not limited to, unjamming of grinder mechanism, periodic motor maintenance, and periodic cleaning of liquid level controls. Should the Contractor elect to submit a performance bond in lieu of the experience clause outlined above, this Warranty Performance Certification shall also be used as a criterion to evaluate the Contractor performance over the warranty period. A Warranty Performance Certification form is included with the bid schedule and must be completed and submitted as part of the bid package. Bids with incomplete forms or missing forms will be considered nonresponsive.

PART 2 - PRODUCTS

2.01 PUMP AND GRINDER

- A. The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of the processing cavity type with a single mechanical seal. Double radial O-ring seals are required at all casting joints to minimize corrosion and create a protective barrier. All pump castings shall be cast iron, fully epoxy coated to 8-10 mil Nominal dry thickness, wet applied. The rotor shall be through-hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specifically compounded ethylene propylene synthetic elastomer. This material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, excellent aging properties, and outstanding wear resistance. Buna-N is not acceptable as a stator material because it does not exhibit the properties as outlined above and required for wastewater service.
- B. The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller (cutter wheel) assembly shall be securely fastened to the pump motor shaft by means of a threaded connection attaching the grinder impeller to the motor shaft. Attachment by means of pins or keys will not be acceptable. The grinder impeller shall be a one-piece, 4140

cutter wheel of the rotating type with inductively hardened cutter teeth. The cutter teeth shall be inductively hardened to Rockwell 50 – 60c for abrasion resistance. The shredder ring shall be of the stationary type and the material shall be white cast iron. The teeth shall be ground into the material to achieve effective grinding. The shredder ring shall have a staggered tooth pattern with only one edge engaged at a time, maximizing the cutting torque. These materials have been chosen for their capacity to perform in the intended environment as they are materials with wear and corrosive resistant properties.

C. This assembly shall be dynamically balanced and operate without objectionable noise or vibration over the entire range of recommended operating pressures. The grinder shall be constructed so as to minimize clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour the tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:

1. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
2. The maximum flow rate through the cutting mechanism must not exceed 4 feet per second. This is a critical design element to minimize jamming and as such must be adhered to.
3. The inlet shroud shall have a diameter of no less than 5 inches. Inlet shrouds that are less than 5 inches in diameter will not be accepted due to their inability to maintain the specified 4 feet per second maximum inlet velocity which by design prevents unnecessary jamming of the cutter mechanism and minimizes blinding of the pump by large objects that block the inlet shroud.
4. The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.

The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of “foreign objects,” such as paper, wood, plastic, glass, wipes, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4" diameter stainless steel discharge piping.

D. The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of “foreign objects”, such as paper, wood, plastic, glass, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4" diameter s/s discharge piping.

E. As a maximum, the motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with Class F installation, low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds.

The motor shall be press-fit into the casting for better heat transfer and longer winding life. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. This motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc., for the application. Non-capacitor start motors or permanent split capacitor motors will not be accepted because of their reduced starting torque and consequent diminished grinding capability. The wet portion of the motor armature must be 300 Series stainless. To reduce the potential of environmental concerns, the expense of handling and disposing of oil, and the associated maintenance costs, oil-filled motors will not be accepted.

- F. The pump/core shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring.

2.02 TANK AND INTEGRAL ACCESSWAY

- A. The tank shall be a wetwell design consisting of a single wall, laminated fiberglass construction. The resin used shall be of a commercial grade suitable for the environment. The reinforcing material shall be a commercial grade of glass fiber capable of bonding with the selected resin. The inner surface shall have a smooth finish and be free of cracks and crazing. The exterior tank surface shall be relatively smooth with no exposed fiber or sharp projections present.
- B. The tank wall and bottom shall be of sufficient thickness and construction to withstand the imposed loading due to saturated soil at the specified burial depth for each available tank height. All station components must function normally when exposed to the external soil and hydrostatic pressures developed at the specified burial depth. The tank bottom shall be reinforced with a fiberglass plate extending beyond the tank walls to support concrete anchoring, as required, to prevent flotation.
- C. The Fiberglass tank shall have a stainless steel discharge bulkhead which terminates outside the tank wall with a 1-1/4" female pipe thread. The discharge bulkhead shall be factory installed and warranted by the manufacturer to be watertight. The tank shall be furnished with a field installed EPDM grommet to accept a 4.50" OD (4" DWV or SCH 40) inlet pipe.
- D. The power and control cable shall connect to the pump by means of the provided NEMA 6P Electrical Quick Disconnect (EQD) and shall enter the tank through a field installed watertight strain relief connector supplied by the manufacturer. An electrical junction box shall not be permitted in the tank. Installation of the inlet grommet and cable strain relief shall require field penetration of the tank wall by the installing party. The tank shall also be vented to prevent sewage gases from accumulating inside the tank by means of a factory-provided, field-installed mushroom vent. The station cover shall be factory drilled to accept the mushroom

vent. The tank and stainless steel discharge bulkhead shall be factory-tested to be watertight.

- E. Consult the contract drawings for station tank sizes (diameter and height).

2.03 MISCELLANEOUS

- A. **Discharge Hose and Disconnect Valve:** All discharge fittings and piping shall be constructed of polypropylene, EPDM or PVC. The discharge hose assembly shall include a shut-off valve rated for 200 psi WOG and a quick disconnect feature to simplify installation and pump removal. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.
- B. **Electrical Quick Disconnect:** The grinder pump core shall include a factory-installed NEMA 6P electrical quick disconnect (EQD) for all power and control functions. The EQD will be supplied with 32', 25' of useable, electrical supply cable (ESC) to connect to the alarm panel. The EQD shall require no tools for assembly, seal against water before the electrical connection is made, and include radial seals to assure a watertight seal regardless of tightening torque. Plug-type connections of the power cable onto the pump housing will not be acceptable due to the potential for leaks and electrical shorts. Junction boxes are not acceptable due to the large number of potential leak points. The EQD shall be so designed to be conducive to field wiring as required.
- C. **Check Valve:** The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the discharge piping. The check valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Moving parts will be made of a 300 Series stainless steel and fabric reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a very low back-pressure. The valve body shall be an injection molded part made of an engineered thermoplastic resin. The valve shall be rated for continuous operating pressure of 235 psi. Ball-type check valves are unacceptable due to their limited sealing capacity in slurry applications.
- D. **Anti-Siphon Valve:** The pump discharge shall be equipped with a factory-installed, gravity-operated, flapper-type integral anti-siphon valve built into the discharge piping. Moving parts will be made of 300 Series stainless steel and fabric-reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly, providing a maximum degree of freedom to ensure proper operation even at a very low pressure. The valve body shall be injection-molded from an engineered thermoplastic resin. Holes or ports in the discharge piping are not acceptable anti-siphon devices due to their tendency to clog from the solids in the slurry being

pumped. The anti-siphon port diameter shall be no less than 60% of the inside diameter of the pump discharge piping.

- E. Core Unit: The grinder pump station shall have an easily removable core assembly containing pump, motor, grinder, all motor controls, check valve, anti-siphon valve, electrical quick disconnect and wiring. The watertight integrity of the core unit shall be established by a 100% factory test at a minimum of 5 PSIG.
- F. Stainless Steel Curb Stop/Check Valve Assembly (UNI-LATERAL): The curb stop shall be pressure-tight in both directions. The ball valve actuator shall include position stop features at the fully opened and closed positions. The curb stop/check valve assembly shall be designed to withstand a working pressure of 235 psi.

The stainless steel check valve shall be integral with the curb stop valve. The check valve will provide a full-ported 1-1/4" passageway and shall introduce minimal friction loss at maximum rated flow. The flapper hinge design shall provide a maximum degree of freedom and ensure seating at low back pressure.

1. Engineered Thermoplastic Fittings – All plastic fitting components are to be in compliance with applicable ASTM standards. All pipe connections shall be made using compression fitting connections including a Buna-N O-ring for sealing to the outside diameter of the pipe. A split-collet locking device shall be integrated into all pipe connection fittings to securely restrain the pipe from hydraulic pressure and external loading caused by shifting and settling.
2. Curb Boxes – Curb boxes shall be constructed of ABS, conforming to ASTM-D 1788. Lid top casting shall be cast iron, conforming to ASTM A-48 Class 25, providing magnetic detectability, and be painted black. All components shall be inherently corrosion-resistant to ensure durability in the ground. Curb boxes shall provide height adjustment downward (shorter) from their nominal height.
3. High Density Polyethylene Pipe (Supplied by others) – Pipe shall be have a working pressure of 160 psi minimum and shall be classified SDR per ASTM D 3035.
4. Pipe Dimensions – The SDR (Standard Dimension Ratio) of the pipe supplied shall be as specified by the SPECIFYING ENGINEER. SDR 7, 9 and 11 fittings are available from the manufacturer.
5. Factory Test – The stainless steel, combination curb stop/check valve component shall be 100 percent hydrostatically tested to 150 psi in the factory.
6. Construction Practices – Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked

for storage, such stacking should be in accordance with the pipe manufacturer's recommendations. The pipe should be handled in such a manner that it is not damaged by being dragged over sharp objects or cut by chokers or lifting equipment. Segments of pipe having cuts or gouges in excess of 10 percent of the wall thickness of the pipe shall be cut out and removed. The undamaged portions of the pipe shall be rejoined using the butt fusion joining method. Sections of polyethylene pipe should be joined into continuous lengths on the job site above ground. The joining method shall be the butt-fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt-fusion equipment used in the joining procedure shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, fusion temperature, alignment, and fusion pressure. Fused segments of pipe shall be handled so as to avoid damage to the pipe. When lifting fused sections of pipe, chains or cable-type chokers should be avoided. Nylon slings are preferred. Spreader bars should be used when lifting long, fused sections. Care should be exercised to avoid cutting or gouging the pipe.

7. Installation – Assemble the compression fittings according to the fitting manufacturer's recommendations.
 8. The trench and trench bottom should be constructed in accordance with ASTM D 2321. Embedment materials should be Class I, Class II or Class III materials as defined in ASTM D 2321. The use of Class IV and/or Class V materials for embedment is not recommended and should be allowed only with the approval of the SPECIFYING ENGINEER. Bedding of the pipe should be performed in accordance with ASTM D 2321. Compaction should be as specified in ASTM D 2321. Deviations from the specified compaction shall be approved by the SPECIFYING ENGINEER.
 9. Haunching and initial backfill should be as specified in ASTM D 2321 using Class I, Class II or Class III materials. Materials used and compaction shall be as specified by the SPECIFYING ENGINEER. In cases where a compaction of 85 percent Standard Proctor Density is not attainable, the SPECIFYING ENGINEER may wish to increase the SDR of the pipe to provide adequate stiffness. ASTM D 2321 sections titled "Minimum Cover for Load Application," "Use of Compaction Equipment" and "Removal of Trench Protection" should apply unless directed otherwise by the SPECIFYING ENGINEER.
- G. Serviceability: The grinder pump core, including level sensor assembly, shall have two lifting hooks complete with lift-out harness connected to its top housing to facilitate easy core removal when necessary. The level sensor assembly must be easily removed from the pump assembly for service or replacement. All mechanical and electrical connections must provide easy disconnect capability for core unit removal and installation. Each EQD half must include a water-tight cover to protect the internal electrical pins while the EQD is unplugged. A pump push-to-run feature

will be provided for field trouble shooting. The push-to-run feature must operate the pump even if the level sensor assembly has been removed from the pump assembly. All motor control components shall be mounted on a readily replaceable bracket for ease of field service.

- H. OSHA Confined Space: All maintenance tasks for the grinder pump station must be possible without entry into the grinder pump station (as per OSHA 1910.146 Permit-required confined spaces). *“Entry means the action by which a person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant’s body breaks the plane of an opening into the space.”*
- I. Safety: The grinder pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired grinder pump station shall be listed by Underwriters Laboratories, Inc., to be safe and appropriate for the intended use. UL listing of components of the station, or third-party testing to UL standard are not acceptable. The grinder pump shall meet accepted standards for plumbing equipment for use in or near residences, shall be free from noise, odor, or health hazards, and shall have been tested by an independent laboratory to certify its capability to perform as specified in either individual or low pressure sewer system applications. As evidence of compliance with this requirement, the grinder pump shall bear the seal of NSF International. Third-party testing to NSF standard is not acceptable.

2.04 CONTROLS

- A. All necessary motor starting controls shall be located in the cast iron enclosure of the core unit secured by stainless steel fasteners. Locating motor starting controls in a plastic enclosure is not acceptable. Wastewater level sensing controls shall be housed in a separate enclosure from motor starting controls. Level sensor housing must be sealed via a radial type seal; solvents or glues are not acceptable. Level sensing control housing must be integrally attached to pump assembly so that it may be removed from the station with the pump and in such a way as to minimize the potential for the accumulation of grease and debris accumulation, etc. Level sensing housing must be a high-impact thermoplastic copolymer over-molded with a thermo plastic elastomer. The use of PVC for the level sensing housing is not acceptable.
- B. Non-fouling wastewater level controls for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air column connected to a pressure switch. The air column shall be integrally molded from a thermoplastic elastomer suitable for use in wastewater and with excellent impact resistance. The air column shall have only a single connection between the water level being monitored and the pressure switch. Any connections are to be radial sealed with redundant O-rings. The level detection device shall have no moving parts in direct contact with the wastewater and shall be integral to the pump core assembly in a single, readily-exchanged unit. Depressing the push to run button must operate the pump even with the level sensor housing removed from the pump.

- C. All fasteners throughout the assembly shall be 300 Series stainless steel. High-level sensing will be accomplished in the manner detailed above by a separate air column sensor and pressure switch of the same type. Closure of the high-level sensing device will energize an alarm circuit as well as a redundant pump-on circuit. For increased reliability, pump ON/OFF and high-level alarm functions shall not be controlled by the same switch. Float switches of any kind, including float trees, will not be accepted due to the periodic need to maintain (rinsing, cleaning) such devices and their tendency to malfunction because of incorrect wiring, tangling, grease buildup, and mechanical cord fatigue. To assure reliable operation of the pressure switches, each core shall be equipped with a factory installed equalizer diaphragm that compensates for any atmospheric pressure or temperature changes. Tube or piping runs outside of the station tank or into tank-mounted junction boxes providing pressure switch equalization will not be permitted due to their susceptibility to condensation, kinking, pinching, and insect infestation. The grinder pump will be furnished with a 6 conductor 14 gauge, type SJOW cable, pre-wired and watertight to meet UL requirements with a FACTORY INSTALLED NEMA 6P EQD half attached to it.

2.05 ALARM PANEL

- A. Each grinder pump station shall include a NEMA 4X, UL-listed alarm panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of thermoplastic polyester to ensure corrosion resistance. The enclosure shall include a hinged, lockable cover with padlock, preventing access to electrical components, and creating a secured safety front to allow access only to authorized personnel. The enclosure shall not exceed 10.5" W x 14" H x 7" D, or 12.5" W x 16" H x 7.5" D if certain options are included.
- B. The alarm panel shall contain one 15-amp, double-pole circuit breaker for the pump core's power circuit and one 15-amp single-pole circuit breaker for the alarm circuit. The panel shall contain a push-to-run feature, an internal run indicator, and a complete alarm circuit. All circuit boards in the alarm panel are to be protected with a conformal coating on both sides and the AC power circuit shall include an auto resetting fuse.
- C. The alarm panel shall include the following features: external audible and visual alarm; push-to-run switch; push-to-silence switch; redundant pump start; and high level alarm capability. The alarm sequence is to be as follows when the pump and alarm breakers are on:
1. When liquid level in the sewage wet-well rises above the alarm level, the contacts on the alarm pressure switch activate, audible and visual alarms are activated, and the redundant pump starting system is energized.
 2. The audible alarm may be silenced by means of the externally mounted, push-to-silence button.

3. Visual alarm remains illuminated until the sewage level in the wet-well drops below the “off” setting of the alarm pressure switch.
 4. The visual alarm lamp shall be inside a red, oblong lens at least 3.75" L x 2.38" W x 1.5" H. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating. The audible alarm shall be externally mounted on the bottom of the enclosure, capable of 93 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch that is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure (push-to-silence button).
- D. The entire alarm panel, as manufactured and including any of the following options shall be listed by Underwriters Laboratories, Inc.

PART 3 - EXECUTION

3.01 FACTORY TEST

- A. A. Each grinder pump shall be submerged and operated for 1.5 minutes (minimum). Included in this procedure will be the testing of all ancillary components such as, the anti-siphon valve, check valve, discharge assembly and each unit's dedicated level controls and motor controls. All factory tests shall incorporate each of the above listed items. Actual appurtenances and controls which will be installed in the field shall be particular to the tested pump only. A common set of appurtenances and controls for all pumps is not acceptable. Certified test results shall be available upon request showing the operation of each grinder pump at two different points on its curve. Additional validation tests include integral level control performance, continuity to ground and acoustic tests of the rotating components. The Engineer reserves the right to inspect such testing procedures with representatives of the County at the Grinder Pump Manufacturer's facility.
- B. All HDPE basins shall be factory leak tested to assure the integrity of all joints, seams and penetrations. All necessary penetrations such as inlets, discharge fittings and cable connectors shall be included in this test along with their respective sealing means (grommets, gaskets etc.).

3.02 DELIVERY

All grinder pump core units, including level controls, will be delivered to the job site 100 percent completely assembled, including testing, ready for installation. Grinder pump cores will be shipped separately from the tanks. Installing the cores and discharge piping/hose into the tanks is the only assembly step required and allowed due to the workmanship issues associated with other on-site assembly. Grinder pump cores must be boxed for ease of handling.

3.03 INSTALLATION

- A. Earth excavation and backfill as specified elsewhere is to be done as a part of the work under this section, including any necessary sheeting and bracing. The Contractor shall be responsible for handling groundwater to provide a firm, dry subgrade for the structure, and shall guard against flotation or other damage resulting from general water or flooding. The grinder pump stations shall not be set into the excavation until the installation procedures and excavation have been approved by the Engineer.
- B. Remove packing material. Users instructions must be given to the Owner. Hardware supplied with the unit, if required, will be used at installation. The basin will be supplied with a standard 4" inlet grommet (4.50" OD) for connecting the incoming sewer line. Appropriate inlet piping must be used. The basin may not be dropped, rolled or laid on its side for any reason.
- C. Installation shall be accomplished so that 1" to 4" of accessway, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the hole must be large enough to allow for the concrete anchor.
- D. A 6" (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit. A concrete anti-flotation collar, as detailed on the drawings, and sized according to the manufacturer's instructions, shall be required and shall be pre-cast to the grinder pump or poured in place. Each grinder pump station with its pre-cast anti-flotation collar shall have a minimum of three lifting eyes for loading and unloading purposes. If the concrete is poured in place, the unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured.
- E. The Contractor will provide and install a 4-foot piece of 4-inch SCH 40 PVC pipe with watertight cap, to stub-out the inlet for the property owners' installation contractor, as depicted on the contract drawings.
- F. The electrical enclosure shall be furnished, installed and wired to the grinder pump station by the Contractor. An alarm device is required on every installation, there shall be NO EXCEPTIONS. It will be the responsibility of the Contractor and the Engineer to coordinate with the individual property owner(s) to determine the optimum location for the alarm panel.

The Contractor shall mount the alarm device in a conspicuous location, as per national and local codes. The alarm panel will be connected to the grinder pump station by a length of 6-conductor type TC cable as shown on the contract drawings. The power and alarm circuits must be on separate power circuits. The grinder pump

stations will be provided with 32 feet, 25 feet of useable, electrical supply cable to connect the station to the alarm panel. This cable shall be supplied with a FACTORY INSTALLED EQD half to connect to the mating EQD half on the core.

3.04 BACKFILL REQUIREMENTS:

- A. Proper backfill is essential to the long-term reliability of any underground structure. Several methods of backfill are available to produce favorable results with different native soil conditions. The most highly recommended method of backfilling is to surround the unit to grade using Class I or Class II backfill material as defined in ASTM 2321. Class 1A and Class 1B are recommended where frost heave is a concern; Class 1B is a better choice when the native soil is sand or if a high, fluctuating water table is expected. Class 1, angular crushed stone, offers an added benefit in that it doesn't need to be compacted.
- B. Class II, naturally rounded stone, may require more compactive effort, or tamping, to achieve the proper density. If the native soil condition consists of clean compactible soil, with less than 12% fines, free of ice, rocks, roots and organic material, it may be an acceptable backfill. Soil must be compacted in lifts not to exceed one foot to reach a final Proctor Density of between 85% and 90%. Heavy, non-compactible clays and silts are not suitable backfill for this or any underground structure such as inlet or discharge lines.
- C. Backfill of clean, native earth, free of rocks, roots, and foreign objects, shall be thoroughly compacted in lifts not exceeding 12" to a final Proctor Density of not less than 85%. Improper backfilling may result in damaged accessways. The grinder pump station shall be installed at a minimum depth from grade to the top of the 1 1/4" discharge line, to assure maximum frost protection. The finish grade line shall be 1" to 4" below the bottom of the lid, and final grade shall slope away from the grinder pump station.
- D. All restoration will be the responsibility of the Contractor. Per unit costs for this item shall be included in the Contractor's bid price for the individual grinder pump station. The properties shall be restored to their original condition in all respects, including, but not limited to, curb and sidewalk replacement, landscaping, loaming and seeding, and restoration of the traveled ways, as directed by the Engineer.

3.05 START UP AND FIELD TESTING

- A. The Manufacturer shall provide the services of qualified factory trained technician(s) who shall inspect the placement and wiring of each station, perform field tests as specified herein, and instruct the County's personnel in the operation and maintenance of the equipment before the stations are accepted by the County.
- B. All equipment and materials necessary to perform testing shall be the responsibility of the Contractor. This includes, as a minimum, a portable generator and power cable (if temporary power is required), water in each basin (filled to a depth sufficient to

verify the high level alarm is operating), and opening of all valves in the system. These steps shall be completed prior to the qualified factory trained technician(s) arrival on site.

- C. The services of a trained, factory-authorized technician shall be provided at a rate of 40 hours for every 100 grinder pump stations supplied.
- D. Upon completion of the installation, the authorized factory technicians will perform the following test on each station:
 - 1. Make certain the discharge shut-off valve in the station is fully open.
 - 2. Turn ON the alarm power circuit and verify the alarm is functioning properly.
 - 3. Turn ON the pump power circuit. Initiate the pump operation to verify automatic “on/off” controls are operative. The pump should immediately turn ON.
 - 4. Consult the Manufacturer’s Service Manual for detailed start-up procedures.
- E. Upon completion of the start-up and testing, the Manufacturer shall submit to the Engineer the start-up authorization form describing the results of the tests performed for each grinder pump station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed and any installation deficiencies corrected.

END OF SECTION

SECTION 13 12 05
PRESTRESSED CONCRETE STORAGE TANK

PART 1 – GENERAL

1.01 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 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 a new 1 million gallons (MG) prestressed concrete storage tank as indicated on the drawings and as described in this specification.

1.02 REFERENCES

- A. ACI 117-10 Specification for Tolerances for Concrete Construction and Materials
- B. ACI 301/301M-10 – Specifications for Structural Concrete for Buildings.
- C. ACI 305R-10 – Guide to Hot Weather Concreting.
- D. ACI 306R-10 – Guide to Cold Weather Concreting.
- E. ACI 347R-04 – Guide to Formwork for Concrete.
- F. ACI 350/350R-06 – Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- G. ACI 350.3-06 – Seismic Design of Liquid-Containing Concrete Structures and Commentary.
- H. ACI 372R-03 – Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.
- I. ACI 506R-05 – Guide to Shotcrete.
- J. ACI 506.2-95 – Specification for Materials, Proportioning, and Application of Shotcrete.
- K. ACI SP4: Formwork for Concrete.

- L. ANSI/AWWA C652-11 – Disinfection of Water Storage Facilities.
- M. ANSI/AWWA D110-04 – Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
- N. ASCE Standard 7-10 – Minimum Design Loads for Buildings and Other Structures.
- O. ASTM A416/A416M-12a – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
- P. ASTM A615/A615M-12 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- Q. ASTM A653/653M-11 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by Hot Dip Process.
- R. ASTM A821/A821M-10 – Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.
- S. ASTM A882/A882M-04(2010) – Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Strand.
- T. ASTM A884/A884M-12 – Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.
- U. ASTM A1064/A1064M-12 – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- V. ASTM C31/C31M-12 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- W. ASTM C33/C33M-13 – Standard Specification for Concrete Aggregates.
- X. ASTM C39/C39M-12a – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- Y. ASTM C143/C143M-12 – Standard Test Method for Slump of Hydraulic-Cement.
- Z. ASTM C172/C172M-10 – Standard Practice for Sampling Freshly Mixed Concrete.
- AA. ASTM C231/C231M-10 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

- BB. ASTM C881/C881M-10 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- CC. ASTM D1056-07 – Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
- DD. ASTM D1557-12 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- EE. ASTM F593-13 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- FF. "Earthquake Induced Sloshing in Tanks with Insufficient Freeboard" by P.K. Malhotra, Structural Engineering International, IASBSE, 3/2006 pp 222-225.

1.03 SUBMITTALS

- A. Prequalification Data: Provide prequalification data prior to the bid in accordance with Section 1.4 B. of this specification.
- B. 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.

Submit detailed design drawings sealed by a professional engineer registered in the state of Florida.
- C. 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.
- D. Design Data: Submit structural calculations for the tank, signed and sealed by a professional engineer in accordance with Section 1.4 A.3 of this specification.

- E. 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.
- F. 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.
- G. Warranty Document: Submit warranty document in Owner's name in accordance with Section 1.6 A. of this specification.
- H. Cleaning and Disinfection Plan: Submit a cleaning and disinfection plan which complies with Section 3.4 of this specification.
- I. 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.

1.04 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. Design: All design work for the tank shall be performed by a professional engineer registered in the state of Florida 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.

4. The diaphragm design and epoxy injection procedure shall have been used in the ten tanks required in Section 1.4 A.1 of this specification.

B. Prequalification:

1. All tank construction companies must be prequalified and meet the criteria stated in Section 1.4 A.1 of this specification to be considered an acceptable tank builder.
2. A complete prequalification package shall be submitted to the Engineer for consideration 14 days prior to the date set for receipt of bids. The prequalification submittal shall include the following items:
 - a. Complete construction drawings showing the principal sizes, thicknesses, reinforcing size and spacing for all structural members including: floor, wall, dome shell and dome edge.
 - b. Complete details of other structural appurtenances as required by the project drawings showing principal sizes, thickness and reinforcing sizes and spacing.
 - c. Complete design calculations which address applicable loads provided in Section 1.7 B. of this specification.
 - d. Complete experience record for the tanks used to meet the experience requirement of Section 1.4 A. of this specification that have been designed and built in the tank construction company's own name and shall include only those tanks that are under the company's warranty. The record shall include the size of the tank, name, address and telephone number of the Owner, the year of construction and the name and telephone number of the Engineer for the project.
 - e. Experience in prestressed concrete tanks of the type specified herein for the construction superintendent, foreman, and three most experienced tankbuilders. Experience shall be with the bidder during the three previous years.
 - f. Construction schedule which details the duration for tank construction.
3. The following are preapproved as acceptable tank construction companies:
 - a. The Crom Corporation, Gainesville, Florida.
 - b. Precon Corporation, Newberry, Florida

1.05 WARRANTY

- A. Provide a warranty document for workmanship and materials on the complete structural portion of the tank for a five-year period from the date of acceptance of the work. In case 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. This 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.

1.06 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: 1,000,000 Gallons
 2. Dimensions: 70'-0" Inside Diameter
34'-9" Water Depth
 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. The minimum roof live load for the structure shall be 12 PSF.
 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 7.
- C. Subbase: A granular base material shall be used beneath the membrane slab when the subgrade materials do not allow free drainage.
1. The base material should consist of a clean, well-compacted, angular or sub-angular material with a minimum thickness of 6 in.
 2. The gradation of the base material should be selected to permit free drainage without the loss of fines or intermixing with the subgrade material.
 3. The maximum particle size of the base material should be limited to provide a relatively level working surface without potential intrusion of the base materials into the membrane floor slab concrete.
 4. Base material should be compacted to 95 percent of the maximum laboratory density determined by ASTM D1557.
- D. Floor: The design of the floor for the prestressed concrete tank shall conform to the following:
1. Concrete membrane floors shall be a minimum of 4" thick and have a minimum thickness of 8" of concrete over all pipe encasements and around sumps.
 2. A minimum percentage of 0.60% reinforcing steel shall be used in the membrane floor. The minimum percentage shall apply to all thickened sections and shall extend a minimum of 2 ft into the adjacent membrane floor.
- E. 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" 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".
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. $1250 \text{ psi} + 75t \text{ psi/in.}$ 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. $1250 \text{ psi} + 75t \text{ psi/in.}$ 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.

F. 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".
 - 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.

G. 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.

H. Wall Openings:

- 1. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall be no less than 18" above the floor slab. 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" unless an axi-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

2.01 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.

2.02 CONCRETE

- A. Concrete shall conform to ACI 301/301M.
- B. All concrete shall utilize Type I/II 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)	Maximum Aggregate Size (in)	Maximum W/C Ratio	Slump (in)
Floor	4000	560	¾	0.45	4"+/-1"
Dome	4000	600	¾	0.45	4"+/-1"

2.03 SHOTCRETE

- A. Shotcrete shall conform to the requirements of ACI 506.2 except as modified herein.
- B. All shotcrete mixes shall utilize Type I/II 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	Slump (in)	Fiber Reinforcement (lbs/cyd)
Core Wall	4000	0.42	4"+/-1"	-
Covercoat	4000	0.42	4"+/-1"	

2.04 MOISTURE BARRIER

- A. The moisture barrier shall be polyethylene, Class A, conforming to ASTM D4397 with a minimum thickness of 6-mils.

2.05 PRESTRESSED REINFORCEMENT

- B. The prestressing wire shall conform to the requirements of ASTM A821/A821M, Type B.
- C. The prestressing wire size shall be 0.162" (8 gauge), 0.192" (6 gauge) or larger, but no larger than 0.250".
- D. 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.
- E. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the prestressing reinforcement and shall develop the full strength of the wire.

2.06 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.

2.07 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 in. 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.

2.08 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 polyvinyl chloride.
- 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.

2.09 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 SEISMIC RESTRAINT CABLES

- A. When required by design, seismic restraint cables shall be seven-wire strand conforming to ASTM A416/A416M.

- B. The strand shall be protected with a fusion-bonded, grit-impregnated epoxy coating conforming to ASTM A882/A882M.
- C. The minimum yield strength of the seven-wire strand shall be 270,000 psi.

2.11 ACCESSORIES

- A. The tank contractor shall furnish and install those accessories shown on the drawings.
- B. 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.
- C. Thru wall pipe sleeves shall be 316 stainless steel and shall seal the thru pipe with neoprene link-seal units using stainless steel bolts.
- D. 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) standards using gas tungsten arc welding (GTAW) 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.
- E. Interior ladder shall be fabricated from fiberglass 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.
- F. Roof hatch cover, roof ventilator, and liquid level indicator shall be fabricated from fiberglass.

- G. Accessory hardware, unless otherwise noted, shall be Type 316 stainless steel conforming to ASTM F593.

2.12 COATINGS

- A. 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-SP1.
 - 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

3.01 EXAMINATION

- A. All subgrade elevations shall be verified prior to starting tank construction.

3.02 INSTALLATION

- A. Floor:
 - 1. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.
 - 2. A 6-mil polyethylene vapor-barrier shall be placed after subgrade preparation has been completed.
 - 3. Form and screed boards shall be of proper thickness and sufficiently braced to ensure that the floor is constructed within proper thickness tolerances.
 - 4. Plate bolsters shall be used to support reinforcing steel supported directly on the subgrade to ensure positive control of placement of reinforcing steel.
 - 5. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.
 - 6. The floor shall be water cured for a minimum of 7 days after casting.

7. The floor shall receive a light broom finish.

B. Core Wall:

1. The wall shall be constructed 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 2.8 Epoxy.

b. Shotcrete:

- (1) All shotcrete shall be applied by or under direct supervision of experienced nozzle men certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.
- (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 1/8" thick shotcrete shall separate reinforcing steel and prestressing wire.
- (5) The diaphragm shall be encased and protected with no less than 1" 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 2.8 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 1/8" thick.

F. Covercoat:

1. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1" 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. DECORATIVE COATINGS

1. The exterior coatings of the tank (concrete surfaces and metallic surfaces) shall be coated by the tank construction company. The tank construction company shall have system responsibility for all coatings and shall not subcontract the work.
2. All coatings shall be applied a minimum of 28 days 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.

3.03 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.

3.04 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

SECTION 13 34 10

PRECAST CONCRETE RESTROOM BUILDING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Contractor to furnish a precast concrete building to be field assembled by the manufacturer on the contractor's poured-in-place foundation or precast concrete floor panel as indicated on contract drawings and in accordance with manufacturer's recommendations. Building shall be provided by manufacturer with all necessary openings as specified by contractor in conformance with manufacturer's structural requirements.

1.02 REFERENCES

- A. ACI-318-11: Building Code Requirements for Structural Concrete and Commentary
- B. ASCE/SEI 7-10: Minimum Design Loads for Buildings and Other Structures
- C. IBC 2012: International Building Code
- D. PCI Design Handbook, 7th Edition
- E. Concrete Reinforcing Institute, Manual of Standard Practice
- F. UL-752 (Test Method level 5) for bullet resistance certified by a military approved laboratory.

1.03 SYSTEM DESCRIPTION AND DESIGN REQUIREMENTS

- A. Building Dimensions:
- B. Exterior: 10' x 12' x 8'-4" (excluding cast-in-place concrete floor slab)
- C. Interior: 9'-6" x 11'-6" x 8'-0"
- D. Design Loads:
 - 1. Seismic Design Category 'D', Risk Design Category III
 - 2. Roof Live Load (Snow) – 60 PSF
 - 3. Floor Live Load – 250 PSF (if precast floor is provided)

4. Wind Loading* – 165 MPH

*Design loads relate to precast components only, not accessories (i.e. doors, windows, vents, etc.)

- E. Roof: Roof panel shall slope ½" from front to back in 10-foot direction. The roof shall extend a minimum of 2 ½" beyond the wall panel on each side and have a turndown design which extends ½" below the top edge of the wall panels to prevent water migration into the building along top of wall panels. Roof shall also have an integral architectural ribbed edge.
- F. Roof, floor, and wall panels must each be produced as single component monolithic panels. No roof, floor, or vertical wall joints will be allowed, except at corners and along perimeter. Wall panels shall be set on top of floor panel.
- G. Floor panel or contractor supplied cast-in-place slab must have ½" step-down around the entire perimeter to prevent water migration into the building along the bottom of wall panels.

1.04 SUBMITTALS

- A. Engineering calculations that are designed and sealed by a professional engineer, licensed to practice in the state where the project is located, shall be submitted for approval.
- B. Manufacturers' product literature shall be provided for any plumbing, electrical, and miscellaneous installed fixtures demonstrating compliance with these specifications.

1.05 QUALITY ASSURANCE

- A. The precast concrete building producer shall be a plant-certified member of either the National Precast Concrete Association (NPCA), The Precast/Prestressed Concrete Institute (PCI), or equal.
- B. The precast concrete building producer shall demonstrate product knowledge and must have a minimum of 5 years' experience manufacturing and setting precast concrete.
- C. The manufacturer must be a licensed producer of pre-engineered recast concrete buildings. The building shall be designed, constructed and delivered with the best practices and methods and shall be as manufactured by one of the following:
 - 1. EASI-SET®
 - 2. Concrete Modular Systems, St Petersburg

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Concrete: Steel-reinforced, 5000 PSI minimum 28-day compressive strength, air-entrained (ASTM C260).
- B. Reinforcing Steel: ASTM A615, grade 60 unless otherwise specified.
- C. Welded Wire Fabric: ASTM 185, Grade 65
- D. Post-tensioning Strand: 41K Polystrand CP50, ½” 270 KSI Seven-Wire strand, enclosed within a greased plastic sheath (ASTM A416). Roof and floor each shall be post-tensioned by a proprietary, second generation design using a single, continuous tendon. Said tendon is placed in the concrete slab to form a perimeter loop starting from one corner of the slab to a point where the cable entered the slab. The tendon then turns 90 degrees and follows the cable member(s) in the periphery to a point midway along the “X” axis of the concrete building panel and then turns 90 degrees along the “Y” axis of the concrete building panel. This bisects the concrete building panel and crosses the opposite parallel portion of the cable member and exits from an adjacent side of the concrete building panel. This creates a cable pattern with no less than 2.5 parallel cables in any direction. To ensure a watertight design, no alternate methods shall be substituted for the post-tensioning.
- E. Sealant: All joints between panels shall be caulked on the exterior and interior surface of the joints. Caulking shall be DOW CORNING 790 silicone sealant or equal. Exterior caulk reveals to be 3/8”x 3/4” deep so that sides of the joint are parallel for proper caulk adhesion. Back of the joint to be taped with bond breaking tape to ensure adhesion of caulk to parallel sides of joint and not the back.
- F. Vents: Two screened aluminum vents to be cast in rear wall. Vents shall be SUNVENT INDUSTRIES Model FL-164 or equal.
- G. Panel Connections: All panels shall be securely fastened together with 3/8” thick steel brackets. Steel is to be of structural quality, hot-rolled carbon complying with ASTM A36 and hot dipped galvanized after fabrication. All fasteners to be ½” diameter bolts complying with ASTM A325 for carbon steel bolts. Cast-in anchors used for panel connections to be Dayton-Superior F-63 coil inserts, or equal. All inserts for corner connections must be secured directly to form before casting panels. No floating-in of connection inserts shall be allowed. Wall panels shall be connected to cast-in-place floor slab using expansion anchors providing adequate embedment by manufacturer.

2.02 ACCESSORIES

- A. Doors and Frames: Shall comply with Steel Door Institute “Recommended Specifications for Standard Steel Doors and Frames” (SDI-100) and as herein specified. All door and frame galvanizing shall be in accordance with ASTM A924 and A653, A60 minimum coating thickness.
1. The buildings shall be equipped with double 3’-0” x 6’-8” x 1-3/4” thick insulated, 18 gauge, metal doors with 16-gauge frames (to meet wall thickness). Doors to have flush top cap. 12 gauge flat astragals shall be applied to the active leaf to protect against the elements or forced opening. Doors and frames shall be factory bonderized and painted with one coat of rust inhibitive primer and one finish coat of enamel paint; color to be BOLT BROWN unless specified otherwise.
 2. Doors and frames shall meet SDI standard Level 2, 1^{3/4}” heavy duty.
 3. Approved manufacturers: Republic, Steelcraft, Ceko, Black Mountain, Pioneer, Curries, Mesker, MPI, Door components or equal
 4. Approved distributor: Integrated Entry Systems
- B. Door Hardware:
1. Pull Handle: Shall meet requirements of ANSI A156.2. Shall be thru bolt attached and constructed of a minimum 3/4” diameter stainless pull handle sized 8” center to center with a stainless backer plate, minimum 0.053” on both sides.

Approved manufacturers: Design Hardware, or equal
 2. Hinges: Shall comply with ANSI A156.1 and be of the ball bearing, non-removable pin type (3 per door minimum). Hinges shall be 4 1/2” x 4 1/2” US26D (652) brushed chrome finish. Manufacturer shall provide a lifetime limited warranty.

Approved manufacturers: Design Hardware, Don-Jo, or equal
 3. Deadbolt: Commercial Grade Deadbolt conforming to ANSI 156.5 furnished with a 2 1/4” face plate and a 1” projecting deadbolt with hardened steel pins. Dead bolts shall be UL and ADA approved. Finish shall be US26D (626) brushed chrome finish. Manufacturer shall provide a lifetime limited warranty.

Approved manufacturers: Design Hardware, Dorma, or equal
 4. Surface Bolt: 8” Surface bolt UL listed. Finish US26D (626) brushed chrome finish. (2 per inactive leaf)

Approved manufacturers: Don-Jo, Design Hardware, or equal

5. Threshold: Bumper Seal type threshold with a maximum 1" rise to prevent water intrusion. Thresholds shall be approved for UL 10B suitable for use with fire doors rated up to three hours.

Approved manufacturers: National Guard Products or equal

6. Overhead Door Holder: Heavy duty surface mounted hold open device with hold open/stop angle of 85 to 110 degrees. Construction shall be stainless steel. Finish US32D (630) satin stainless steel finish.

Approved manufacturers: ABH, Rockwood, or equal

7. Drip Cap: Aluminum drip cap with minimum projection of 2 ½" shall be furnished.

Approved Manufacturers: Design Hardware, National Guard Products, or equal

8. Doorstop: ANSI 156.16 approved wall mounted door stop with keeper constructed of a corrosion resistant cast brass material. Finish US26D (626) brushed chrome finish.

Approved manufacturers: Don-Jo, Rockwood, or equal

2.03 FINISHES

- A. Interior of Building: Smooth form finish on all interior panel surfaces unless exterior finish is produced using a form liner, then smooth hand-troweled finish.
- B. Exterior of Building: (Standard) Architectural precast concrete brick finish: Finish must be imprinted in top face of panel while in form using an open grid impression tool similar to EASI-BRICK®. Finished brick size shall be 2 3/8" x 7 5/8" with vertical steel float or light broom finish. Joints between each brick must be 3/8" wide x 3/8" deep. Back of joint shall be concave to simulate a hand-tooled joint. Each brick face shall be coated with the following water-based acrylic, water repellent penetrating concrete stain: 1) Canyon Tone stain by United Coatings, 2) Sherwin Williams (H&C concrete stain) or equal. Stain shall be applied per manufacturer's recommendation. Joints shall be kept substantially free of stain to maintain a gray concrete color. Stain color shall be BRICK RED unless specified otherwise.
- C. Exterior of Building (Option #1): Washed brown riverstone applied-aggregate finish on all exterior wall surfaces. Aggregate must be seeded into top of panel while in form, chemically retarded, and high-pressure washed to expose the aggregate to a depth of 1/8".

SECTION 13 34 23

PRECAST CONCRETE BUILDINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all materials, equipment and incidentals required to install precast concrete buildings complete and ready for use.

1.02 GENERAL DESIGN

- A. The structure shall be designed to meet the requirements of loading of the American National Standards Institute (ANSI) "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures", and the requirements of the American Concrete Institute (ACI-318R) "Building Code Requirements for Reinforced Concrete".
- B. The building design will meet or exceed the following minimum loadings:
 - 1. Roof Live Load 60 PSF
 - 2. Floor Live Load 100 PSF
 - 3. Floor Dead Load 75 PSF
 - 4. Wall Wind Load 150 MPH
 - 5. Earthquake Zone 0
- C. The building shall be set on a concrete slab. The slab shall be placed on compacted soil with a minimum bearing capacity of 2,000 PSF. The final floor elevation of the building shall be set a minimum of 4 inches above the final surrounding grade. All electrical conduit work shall be in place before the slab is poured.
- D. The building shall be highly vandal resistant. The building envelope shall be bulletproof to a 308 rifle and steel bullet at 50 feet.
- E. The building shall be designed to be handled and off loaded with an appropriate capacity crane using standard pickups in the roof of the structure.
- F. The precast concrete building shall have the dimensions as shown on the Drawings.

- G. Manufacturer shall maintain a continuous quality control program, and shall submit to the Engineer certified results of the physical test results for concrete and reinforcing.
- H. The building shall have a 2 hour fireproof rating without affecting the structural integrity of the building.
- I. The building shall be shipped without a floor. The CONTRACTOR shall install all below grade electrical work and then pour the concrete slab floor prior to setting building in place. Once set in place the building shall be sealed for water entry at grade.

1.03 QUALITY ASSURANCE

- A. Codes and Standards: Use the following where applicable in design.
 - 1. Building Design - The Standard Building Code.
 - 2. Mechanical NAC Design - The Standard Mechanical Code.
 - 3. Plumbing Design - The Standard Plumbing Code.
 - 4. Electrical Design - The National Electrical Code.
 - 5. American Concrete Institute ACI-318R "Building Code Requirements for Reinforced Concrete".
 - 6. Building Code and regulations of other governing authorities having jurisdiction at the project site.
 - 7. Applicable standards of the American Society for Testing and Materials (ASTM).
 - 8. Ratings by Underwriters Laboratories (UL) and Factory Mutual Research (FM) as required.
- B. Building Manufacturer: The building shall be designed, constructed and delivered with the best practices and methods and shall be as manufactured by one of the following:
 - 1. Concrete Modular Systems, St Petersburg, Florida
 - 2. Leesburg Concrete Company, Inc., Leesburg, Florida
 - 3. Or approved equal.

1.04 SUBMITTALS

- A. Materials and Shop Drawings: Copies of all material required to establish compliance with the Contract Documents shall be submitted. Submittals shall include at least the following:

1. Design Calculations and Erection Drawings: Submittal shall be prepared by, or under the direct supervision of a registered Professional Engineer, licensed to practice in the State of Florida with all drawings and calculations bearing his/her seal and signature.
 2. Submitted shop and erection drawings shall show all important details of construction; dimensions; door and air conditioner locations; lighting, electrical panel and electrical devices locations; pipe and plumbing penetrations and locations; and cabinet and cupboard locations.
 3. Certification: Submit written certification, prepared and signed by a Registered Professional Engineer licensed to practice in State of Florida, attesting that the building design meets specified loading requirements, requirements of codes and authorities having jurisdiction at project site, and other requirements specified.
 4. Descriptive literature, bulletins, and/or catalog data of materials and equipment furnished with the building.
 5. The total weight of the building and equipment including the weight of the single largest item.
 6. A complete total bill of all materials and equipment.
- B. In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe all non- conforming aspects.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Precast concrete buildings shall be shop assembled and tested according to the manufacturer's instructions. A factory representative shall be available to assist during erection of the shelters.
- B. All building sections and equipment 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 & equipment are ready for operation.
- C. All equipment and parts shall be properly protected against any damage during a prolonged storage period at the site.
- D. Each box or package of loose material shall be properly marked to show its net weight in addition to its contents.

1.06 WARRANTY AND GUARANTEES

- A. All buildings, components, materials and equipment supplied under this section shall be warranted for a period of one year by the building manufacturer and the Contractor. Warranty period shall commence on Owner acceptance as

outlined in the General Conditions.

- B. The materials and equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the materials and equipment should fail during the warranty period, it shall be replaced and the unit restored to service at no expense to the Owner.
- C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The precast concrete buildings to be furnished shall be field erected according to the manufacturer's written instructions.
- B. All materials shall be of a quality to withstand corrosion, stresses and ultraviolet radiation.
- C. All materials and equipment provided by the precast concrete building manufacturer shall be guaranteed to be compatible as a total system. Any required variance of the manufacturer's standard product shall be approved by the Engineer before installation

2.02 PRECAST CONCRETE BUILDING

- A. Concrete shall have a compressive strength of 5,000 psi in 28 days. Minimum thickness for walls shall be 3-1/2 inches, the minimum thickness for the floor shall be 5 inches, and the minimum the roof shall be 4 inches at edges and 5 inches at mid-span.
- B. The building roof shall be designed clear span without the use of interior supports of any type. The unfinished building interior ceiling finished height shall be 10 feet minimum.
- C. The building shall be manufactured with a mechanism for assembly under tension at the factory, and provided with joints to be caulked with a Tremco Dymonic compound to maintain a permanent seal under severe weather conditions. The roof joints will be sealed with a 5/8-inch will-seal foam sealant, grouted and covered with a 0.060-inch EPDM membrane roofing strips 12 inches wide cemented to the concrete with a compound designed for this purpose, and sloped 1 inch in 6 feet for drainage.

- D. The building exterior finish shall be 1/2-inch architectural fluted fin finish. The interior shall be insulated on the walls and ceiling. Insulation shall have an R rating of 14.4 and shall have a maximum thickness of 2 inches. The interior shall be finished using fiberglass reinforced plastic.
- E. The building exterior shall be painted with a Class 1 coating system as specified in Section 09 96 00. The concrete floor shall be coated with an acrylic sealer.

2.03 DOORS AND FRAMES

- A. Doors shall be 1-3/4-inch thick aluminum flush doors as manufactured by Cline Aluminum Doors, Alutech Corporation or approved equal. The door core shall be fire-retardant closed cell urethane foam with a minimum insulation R-value of 9.8. The urethane foam shall pass UL 13369 requirements for non-combustible construction systems. A 1-1/4-inch by 4 inch by 1/8-inch thick 6063-T5 aluminum alloy tube shall be provided on all four sides of the door. Door facing shall be 0.04 thickness, smooth surface finish, aluminum sheet laminated to a 0.125-inch thick tempered hardboard. Face sheets and insulated core shall be bonded together with a two-part thermosetting adhesive, to form a waterproof, heat and chemical resistant bond. Entire perimeter of door shall be furnished with a special beveled design using 6063-T5 aluminum alloy extrusions.
- B. Aluminum reinforcing plate, 1/4-inch thick, for attaching door hardware except hinges and door closers shall be provided. Reinforcement on doors for hinges and door closers shall be provided using a 5/16-inch thick aluminum reinforcing plate. Door hinges shall be stainless steel. All tapped holes for mortised hardware shall be made at the factory.
- C. Screws, nuts, washers, bolts, rivets, clips and other miscellaneous fastening devices shall be of aluminum or stainless steel. Pairs of doors shall be equipped with an astragal with weather-stripping.
- D. Door frames shall be furnished by the door manufacturer and shall be constructed of 6063-T5 aluminum alloy extrusions. Wall thickness of the frame shall be a minimum of 0.125-inch. Weather-stripping shall be elastomeric vinyl. Color of weather-stripping for bronze anodized doors shall be black. Door rabbets shall allow for 1-3/4-inch door and weather-stripping. Weather-stripping shall create a weather tight seal when door is installed properly. Door frame corners shall be cut square and fastened together using stainless steel screws and extruded corner brackets. Hinge and door closer reinforcement for frames shall be provided using a 1/4-inch thick aluminum plate drilled and tapped to receive fasteners for hinges and closer brackets. Openings for mortise lock strike plates shall be drilled and tapped.

- E. All doors and frames shall be integral color anodized, NAAMM AA-M21C22A42, with a minimum thickness of 0.7 mils. Color shall be dark bronze No. 313.

2.04 HARDWARE

- A. Catalog numbers refer to Russwin, Corbin, Stanley and Ives and are for the purpose of establishing equality. The products of Schlage, Hager, Sargent, LCN, Yale, Norton, Pemko, Reece and Zero shall be acceptable as approved alternates for the named products. Contractor shall submit hardware schedule as specified herein.
- B. Hardware Requirements:
 - 1. All hardware shall be new and free from defects affecting serviceability or appearance. All working parts shall be well fitted and smooth working. All hardware shall be made of materials as called for.
 - 2. Hardware application to metal shall be made to standard templates. Template information shall be furnished to door and frame fabricators and other trades requiring same, in order that they may cut, reinforced or otherwise shop prepared for receiving hardware. The Contractor shall be fully responsible for checking all details such as wall trim clearance, bevels, rabbets, backsets, etc., in order that all items of hardware shall fit properly.
 - 3. Complete locksets shall be supplied from a single manufacturer. The Owner's existing lockset system shall be used for the precast concrete buildings.
 - 4. Hardware shall be furnished complete with all fastenings.
 - 5. All keys shall be keyed to the Owner's existing keying system. Provide keys as specified herein.
 - 6. Box strikes for all metal frames shall be furnished.
 - 7. Finishes shall be US32D, Satin Stainless Steel, except where noted otherwise.

- C. Hardware Schedule: All door sizes, materials, swings, etc. shall be coordinated with the Drawings. Hardware listed in each Key Set is for each opening as scheduled. Total quantities required shall be determined from the Drawings.

- Door
 - Butt hinges
 - Deadbolt type lockset
 - Retainer hook
 - Exterior pull handle
 - Flush bolts
 - Door Sweep
 - Drip Cap
 - Threshold, extruded bronze
 - Door bottom seal, dark bronze anodized aluminum

2.05 SAFETY FEATURES

- A. Building shall include the following emergency / safety feature devices.
1. Panic Door Release Exit Device: Building door shall be provided with a “Panic Door Release Exit Device” to allow emergency exit from the building. This shall meet Lee County Building Code.
 2. Auxiliary Powered Light: Building shall include an emergency battery backup powered light to provide illumination during the event of a power loss in the building. This shall meet Lee County Building Code.

PART 3 - EXECUTION

3.01 BUILDING INSTALLATION

- A. Each prefabricated, precast concrete building shall be fully assembled, pre-wired, pre-plumbed, finished and coated at the factory. All specified accessories shall be installed by the building manufacturer. The building may be broken down into major components and field erected by the building manufacturer, at his option.
- B. Each building shall be shipped to the jobsite and off loaded and set up at the jobsite by the building manufacturer. Any components and accessories not installed at the factory or broken down for shipping shall be installed in the field by the manufacturer's installation crew.

- C. Buildings shall be installed at the locations indicated on the Drawings. Soil under the buildings shall be compacted to a depth of three feet below the building slab to a compaction of 98 percent modified Proctor density. The building shall be placed on a 12 inch thick compacted crushed stone foundation. The crushed stone foundation shall be flat and level. The final floor elevation of the building shall be set a minimum of 4 inches above the final surrounding grade.

3.02 INSTALLATION OF DOORS, FRAMES AND HARDWARE

- A. Aluminum Door Frames: Door frames shall be installed in correctly prepared openings according to the manufacturer's recommended installation instructions. They shall be set plumb, square and level in correct alignment with floors, ceilings, walls and other work. They shall be securely anchored and completely ready for operation to produce a watertight job. All joints between frames and concrete building shall be tightly caulked with a silicone sealant and neatly pointed. Silicone sealant shall have a color to match the anodized aluminum color. Excess caulking material shall be removed. It shall be the Contractor's responsibility to protect aluminum frame members from damage after installation.
- B. Door Installation: Doors shall be installed plumb, level and true to line. Hardware shall be applied and adjusted to achieve quiet and smooth operation. Door clearances shall not exceed 1/8-inch at jambs and heads and meeting stiles at pairs of doors. Clearance between bottom of door and finished floor material or threshold shall not exceed 1/4-inch. Frames shall be manufactured and machined to within +/- 1/32-inch for all dimensions. The Contractor shall protect door installation from damage after installation.
- C. Hardware Installation: Installation of finish hardware shall be per manufacturer's written instructions.

3.03 INSTALLATION OF AIR CONDITIONING UNIT

- A. Installation of the air conditioning equipment shall be by the CONTRACTOR per the contract drawings.

END OF SECTION

SECTION 26 05 00

ELECTRICAL – GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required for a complete electrical system at the Booster Pump Station Replacement in Nassau County, Florida, hereinafter specified and shown on the Drawings.
- B. The work, apparatus and materials which shall be furnished under these Specifications and accompanying Drawings shall include all items listed hereinafter and/or shown on the Drawings. Certain equipment will be furnished as specified in other sections of these Specifications which will require wiring thereto and/or complete installation as indicated. All materials necessary for the complete installation shall be furnished and installed by the CONTRACTOR to provide complete power, lighting, communication systems, instrumentation, wiring and control systems as indicated on the Drawings and/or as specified herein.
- C. The CONTRACTOR shall furnish and install the necessary cables, transformers, power panels, protective devices, conductors, exterior electrical system, etc., to serve motor loads, lighting loads and miscellaneous electrical loads as indicated on the Drawings and/or as specified hereinafter.
- D. The work shall include complete testing of all equipment and wiring at the completion of the work and making any minor connection changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; sub-standard work will be rejected.
- E. Mount and wire speed indicators, motor starters and process instruments furnished under these or other Divisions of these Specifications.
- F. Make all field connections to process instrument panels and other control panels furnished under other Divisions of these Specifications.
- G. For process instrumentation furnish and install all conduit, wire and interconnections between primary elements, transmitters, local indicators and receivers.
- H. Install and wire all thermostats and other devices furnished under other Divisions of this Specification directly controlling heating equipment or fan motors.
- I. Wire ventilation equipment as required and furnished under other Divisions of this Specification.
- J. Each bidder or his authorized representatives shall, before preparing his proposal, visit all areas in which work under this division is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall

be considered evidence that he or his representative has visited the site and noted the locations and conditions under which the work will be performed and that he takes full responsibility for a complete knowledge of all factors governing his work.

- K. All power interruptions to existing equipment shall be at the Owner's convenience. Each interruption shall have prior approval.
- L. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.

1.02 SERVICE AND METERING

- A. Permanent electrical power shall be provided by Florida Power Utility (FPU) at the voltages indicated on the drawings.
- B. The CONTRACTOR shall schedule all power interruptions with FPU and the OWNER. All interruptions shall have OWNER approval and 48 hour notification.
- C. The CONTRACTOR is responsible for providing all required temporary and permanent power. CONTRACTOR shall include an allowance of \$25,000.00 in the bid for all FPU service installation charges.
- D. CONTRACTOR shall be responsible for all coordination efforts with FPU as required for providing temporary and permanent power.

1.03 CODES, INSPECTION AND FEES

- A. All material and installation shall be in accordance with the latest edition of the National Electrical Code and all applicable national, local and state codes.
- B. Pay all fees required for permits and inspections including any charges associated with the service modifications.

1.04 TESTS

- A. Test all systems and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.
- B. The following minimum tests and checks shall be made prior to the energizing of electrical equipment. Test shall be by the CONTRACTOR and a certified test report shall be submitted stating that the equipment meets and operates in accordance with the Manufacturer's and job specifications, and that equipment and installation conforms to all applicable Standards and Specifications:
 - 1. Testing and setting of protective relays for calibration and proper operation.

2. Mechanical inspection of all circuit breakers 200 amps and larger to assure proper operation.
3. Motors: Megger to ground each motor winding. Record date, motor temperature, terminal, reading and operator and have Owner representative sign off on each reading.
4. Conductors: Megger to ground prior to termination all 600 volt conductors not used for service conductors. Record the date, conductor, reading and operator and have Owner representative sign off on each reading.
5. Data Base: After equipment suppliers test, calibrations, and inspection, megger all circuits leaving the MCCs and panelboards. Record the date, conductor, circuit condition (i.e. load connected or unconnected), reading and operator and have Owner representative sign off on each reading.
6. Hot Spot Testing: Perform infrared hot spot inspection of the service entrance rated automatic transfer switches, switchboards, power panels, motor control center, lighting panels and associated equipment as soon as determined by the Engineer that representative loads are present. Record the date, gear conditions found, operator and have the Owner's representative who must be present for the inspection sign off in each instance.
7. Miscellaneous:
 - a. Meggering must be done at 1000 VDC for one minute. The ground plane used must be the one established at the main source of energy for conductors, service entrance rated ATS, Switchboards, MCC and panel. The motor frame may be used for the ground plane for motors.
 - b. In the course of construction, it will become necessary to temporarily energize some systems for testing. Confirm that any motor has been meggered prior to connection and testing. Do not leave any motor or system unattended and energized without written authorization.
 - c. An unsuccessful test will be one in which any one of the three megger readings differs from another by more than 25%. Engineer shall determine if cables and/or equipment bussing shall be replaced.

1.05 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

1.06 CUTTING AND PATCHING

- A. All cutting and patching shall be done in a thoroughly workmanlike manner.

1.07 INTERPRETATION OF DRAWINGS

- A. The Drawings are not intended to show exact locations of conduit runs.
- B. All three-phase circuits shall be run in separate conduits unless otherwise shown on the Drawings.
- C. Unless otherwise approved by the Engineer conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.
- D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.
- E. The CONTRACTOR shall harmonize the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the CONTRACTOR without additional expense to the Owner. In case interference develops, the Owner's authorized representative is to decide which equipment, piping, etc., must be relocated, regardless which was installed first.
- F. Verify with the Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
- G. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- H. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.
- I. Circuit layouts shown are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the equipment.
- J. The ratings of motors and other electrically operated devices together with the size shown for their branch circuit conductors and conduits are approximate only and are indicative of the probable power requirements insofar as they can be determined in advance of the purchase of equipment.
- K. All connections to equipment shall be made as shown, specified, and directed and in accordance with the Manufacturer's approved shop drawings, regardless of the number of conductors shown on the Electrical Drawings.

1.08 SIZE OF EQUIPMENT

- A. Investigate each space in the building where equipment must pass to reach its final location. If necessary, the Manufacturer shall be required to ship his material in sections, sized to permit passing through such restricted areas in the building.
- B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.09 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of project Contract Drawings. When the project is completed, furnish a complete set of reproducible "As-built" drawings and electronic files (AutoCAD 2019) for the Project Record Documents. These documents shall be 24" x 36" in size.

1.10 COMPONENT INTERCONNECTIONS

- A. Component equipment furnished under this Specification will not be furnished as integrated systems. CONTRACTOR shall field install and wire completely all components.
- B. CONTRACTOR shall analyze all systems components and their shop drawings, identify all terminals and prepare drawings and wiring tables necessary for component interconnection. CONTRACTOR shall provide crimp on wire numbers on both ends of all control wiring installed between all panels furnished under this contract. These numbers shall directly relate to the interconnect wiring drawing furnished by the CONTRACTOR and be reflected in the As-built drawings submitted prior to final acceptance of the project.

1.11 SHOP DRAWINGS

- A. As specified under other sections shop drawings shall be submitted for approval of all materials, equipment, apparatus, and other items as required by the Engineer.
- B. Shop drawings shall be submitted for the following equipment:
 - 1. Precast building.
 - 2. Variable Frequency Drives (VFDs)
 - 3. Full Voltage Non-Reversing Starters
 - 4. Transformers
 - 5. Panelboards
 - 6. Manual Transfer Switches

7. Lighting Contactor Panel
8. Disconnect Switches
9. Circuit Breakers
10. Motor Starters
11. Process Control Panels (PCPs)
12. Back Up Control Panels
13. Remote Telemetry Unit (RTUs)
14. Lighting Fixtures
15. Lightning Protection System
16. Surge Protection Devices
17. Wire and Cable
18. Grounding Systems
19. Conduit Layout Drawings
20. Equipment Racks (with Structural Engineering Certifications)
21. Field Instrument Transmitters and Enclosures
22. Coordination, Short Circuit and Arc Flash Study
23. Generator and Automatic Transfer Switch

C. The Manufacturer name and product designation and catalog data sheet shall be submitted for the following material:

1. Conduit
2. Receptacles
3. Boxes and fittings
4. Switches
5. Lamps
6. Control Relays
7. Grounding Systems Material

- D. Prior to submittal by the CONTRACTOR, all shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list all discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted shall be returned.
- E. The Engineer's check shall be only for conformance with the design concept of the project and compliance with the Specifications and Drawings. The responsibility of, or the necessity of, furnishing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings is included under the work of this Section.
- F. The responsibility for all dimensions to be confirmed and correlated at the job site and for coordination of this work with the work of all other trades is also included under the work of this Section.
- G. No material shall be ordered or shop work started until the Engineer's approval of shop drawings has been given.

1.12 MANUFACTURER SERVICES

- A. Provide Manufacturer services for testing and start-up of the following equipment:
 - 1. Variable Frequency Drives
 - 2. Other items as required by appropriate specification sections.
- B. The Manufacturer of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:
 - 1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "As-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity. The Manufacturer shall provide written approval that equipment supplied is approved for energization.
 - 2. The Field Service Engineers shall provide engineering support during the energization and check out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the Manufacturer's performance specifications.

3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with Manufacturer's test specifications.
4. Two (2) 4-hour training sessions on operation, and two (2) 4-hour training sessions (one for each system) on maintenance and trouble-shooting procedures shall be provided for the Owner's maintenance personnel. All training shall be conducted at a facility provided by the Owner. The maintenance and trouble-shooting sessions shall be conducted with record "As-built" electrical drawings sufficient for a class of eight personnel.
5. A final report shall be written and submitted to the CONTRACTOR within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The CONTRACTOR shall forward a copy of this report to the ENGINEER for approval.

1.13 DEMOLITION

- A. Remove all electrical work associated with equipment shown to be removed (TBR) except those portions indicated to remain or be reused. Remove all unused exposed conduit and wiring back to point of concealment. Remove unused wiring in concealed conduits back to source (or nearest point of usage). Electrical work to be removed corresponds to the associated mechanical equipment to be removed.
- B. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or shall be suitably relocated and the system restored to normal operation. Coordinate outages in systems with the Owner. Where duration of proposed outage cannot be allowed by the Owner, provide temporary connections as required to maintain service.
- C. All removals and relocations of existing installations cannot be completely detailed on the Drawings. Survey the site before submitting bid proposal.
- D. Continuous service is required on all circuits and outlets affected by these changes, except where the Owner will permit outage for a specific time. Obtain Owner's written consent before removing any circuit from continuous service.
- E. Where required to disconnect and/or remove any part of an existing circuit, reconnect that circuit to reestablish service in the remaining portion.
- F. Remove exposed conduits, wireways, outlet boxes, pull boxes and hangers made obsolete by the alternations, unless specifically designated to remain. Exposed conduits shall be removed back to point of concealment, where they shall be cut and threaded for a cap. A threaded cap shall then be installed. Conduits may be removed back to first coupling if within 3-inches of point of concealment. Cut back in traffic areas to the floor level and patch.
- G. Repair all walls to "Like new" condition and paint to match existing wall color.

1.14 DISPOSITION OF REMOVED MATERIALS AND EQUIPMENT

- A. In general, it is intended that all materials and equipment indicated to be removed and disposed of by the CONTRACTOR shall, upon removal, become the CONTRACTOR's property and shall be disposed of off the site by the CONTRACTOR, unless otherwise directed by the Owner.
- B. Reuse of wire will not be permitted. An exception is the reuse or relocation when wire is part of an existing lighting branch circuit and reuse or relocation is specifically designated and can be accomplished without removing and re-pulling the wire.
- C. All reusable and salvageable disconnect switches, starters, control devices, control panels and instruments, receptacles, light fixtures, etc. shall be sorted and returned to the Owner.
- D. All electrical equipment to be salvaged shall be removed and shall be moved by the CONTRACTOR to a location on the site for storage as directed by the Owner.

1.15 CONDUIT LAYOUT DRAWINGS

- A. In addition to the manufacturer's equipment shop drawings, the Contractor shall submit for the approval, electrical installation working drawings for the overall site work, electrical building, pump building and all process areas containing the following:
 - 1. Concealed and buried conduit layouts shown on floor plans drawn at not less than 1/4-inch = 1-foot-0-inch scale. The layouts shall include locations of process equipment, distribution panelboard, transformers, lighting panelboard, control panel and equipment, motors, switches, motor starters, large junction or pull boxes, instruments, and any other electrical devices connected to concealed or buried conduits.
 - 2. Plans shall be drawn on high quality reproducible bond, size 36-inch x 24-inch, and shall be presented in a neat, professional manner.
 - 3. Concrete floors and/or walls containing concealed conduits shall not be poured until conduit layouts are approved.
 - 4. Site plan conduit layout drawings shall be at 1" = 20'-0".
 - 5. Note: AutoCAD drawing files are available from the Engineer.

1.16 MATERIALS

- A. The materials used in all systems shall be new, unused and as hereinafter specified. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or Manufacturer's specifications shall be submitted for approval as required by the Engineer.

- B. Materials and equipment used shall be Underwriters Laboratories, Inc. listed.
- C. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If any apparatus has been damaged, such damage shall be repaired by the CONTRACTOR at his own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the Engineer, at the expense of the CONTRACTOR, or shall be replaced by the CONTRACTOR at his own expense.

1.17 OPERATION AND MAINTENANCE DATA

- A. Submit complete operations and maintenance data for all equipment furnished under this Division in accordance with Division 01. The manuals shall be prepared specifically for this installation and shall include all required cuts, Drawings, equipment lists, descriptions, complete part lists, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.18 WARRANTY

- A. Provide a warranty for all the electrical equipment in accordance with the requirements of other sections, but in no case less than 2 years from date of owner acceptance.

1.19 COORDINATION, SHORT CIRCUIT AND ARC FLASH HAZARD STUDY

- A. General:
 - 1. The Contractor shall provide a Power System Study and Arc Flash Study for the entire electrical power distribution and motor control equipment (new and existing). The studies shall be a totally independent effort to verify adequacy of all of the existing equipment as well as new additions being implemented under these Specifications. The studies shall be prepared by a professional Engineer, registered in the State of Florida, with demonstrated experience in the performance of industrial power system and fault arc hazard analysis. The Engineer may be an employee of an equipment manufacturer or supplier. All work shall be submitted both hard copy and thumb drive. The following firms are approved to perform the short circuit study:
 - a. Judson A. Walker, P.E. (904) 219-0685, Gainesville, Florida
 - b. Industry Electric Design, Inc.-Mr. Don Trawick (678) 617-7507
 - 2. The Contractor shall provide data necessary to perform the study. This includes feeder cable sizes, approximate feeder length motor data, generator data, existing protective relay settings and any other information relevant to the study.

3. A summary of the short circuit analysis shall be provided to the Contractor at the time shop drawings for all of the new equipment is submitted for approval.
4. The Contractor shall provide complete sets of motor control center and emergency generator shop drawings for use in the studies.

B. Scope:

1. The short circuit study shall be in accordance with ANSI Standard C37.010 and C37.13, shall be performed to check the adequacy, and to verify the correct application of circuit protective devices and other system components specified. The study shall address the case when the system is being powered from the normal source as well as from the on-site generating facilities. Minimum as well as maximum possible fault conditions shall be adequately covered in the study.
2. Fault contribution of all motors shall be considered. The Contractor shall be responsible for obtaining all required data of equipment. All back-up calculations shall become part of the final report. The calculations shall be in sufficient detail to allow easy review.
3. The arc flash analysis study shall include the calculations of flash protection boundary limits and the incident energy exposure for the maximum arc producing flash expected from the electrical equipment. The study will determine incident energy exposure level and flash arc protection boundaries for the electrical equipment, based on IEEE-1584 and NFPA-70E. The study shall be based on the protective device settings and interrupting device clearing time.

C. Contents:

1. The study shall include representation of the power company's system, the base quantities selected, impedance source-data, calculation methods and tabulations, one-line and impedance diagrams, conclusions and recommendations. Short-circuit momentary duties, shall be calculated on the basis of an assumed bolted three-phase short circuit at the main breaker, ATS, 480 volt motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the systems. The short circuit tabulations shall include significant X to R ratios, asymmetry factors, KVA, and symmetrical fault current.
2. A protective device time current coordination study shall be included with coordination plots of key and/or limiting devices, tabulated data, rating, and/or settings selected. The study shall present an Engineering balance between the competing objectives of protection and continuity of service for the system specified, taking into account the basic factors of sensitivity, selectivity and speed.

3. Separate plots shall be provided for each mode, "normal," and, "standby," operation. Maximum fault values shall be shown in each case. Both power sources shown in one plot will not be accepted.
4. Existing protective device settings in key locations shall be reviewed to ensure selectivity under the new conditions. Recommended changes shall be indicated in the report. The Contractor shall be made aware of the required changes immediately.
5. Generator short circuit decrement curves and thermal limit curves shall be included.
6. Required settings for breakers and relays shall be maximized to provide the most effective protection possible whether the system is fed from the normal or emergency source.
7. Tabulations indicating recommended set points for all protective devices shall be provided. This shall include the normal as well as the emergency source.
8. Arc Flash study shall include representation of the calculation methods and tabulations, and a one-line drawing of all identifying equipment included in this study. The complete study shall be turned over to the Owner as per 01420. as part of the study, the Contractor shall affix permanent adhesive non-fading labeling indicating the equipment ID number and required information as required by NFPA 70E. Samples of arc flash warning labels are presented below:

 WARNING	
Arc Flash & Shock Hazard Appropriate PPE Required	
Flash Protection Flash Hazard Category 1 Incident Energy <u>2.8</u> (cal/cm ²) Flash Protection Boundary <u>30 inches</u> Glove Class <u>00</u>	Shock Protection <u>480</u> VAC Shock Hazard When Cover is Removed Limited Approach Boundary <u>42 inches</u> Restricted Approach Boundary <u>12 inches</u> Prohibited Approach Boundary <u>1 inch</u>
PPE REQUIRED CAT.1 OR 2 FR SHIRT & PANTS, AR FACE SHIELD, SAFETY GLASSES, LEATHER GLOVES, EAR PLUGS	
*Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements. Review every 5 yrs.	
February 4, 2010	
Bus Name: <u>CLKR-CLR-EF</u> Prot: <u>PD-CLKR-CLR</u>	

Figure 1

 WARNING	
Arc Flash and Shock Hazard Appropriate PPE Required	
Arc Flash Protection • Flash Protection Boundary: _____ • Hazard Risk Category: _____ • Incident Energy at 18" (cal/cm ²): _____	Required PPE ☐ Hard Hat ☐ T-shirt ☐ Safety Glasses ☐ FR Shirt ☐ Safety Goggles ☐ FR Pants ☐ Face Shield ☐ FR Coverall ☐ Flash Hood ☐ Flash Suite ☐ Ear Protection ☐ Leather Shoes ☐ Long Pants ☐ Leather Gloves ☐ Long Sleeve Shirt ☐ Cotton Underwear ☐ Voltage Rated Gloves
Shock Protection Shock Hazard when cover is OPENED or REMOVED: _____ • Limited Approach: _____ • Restricted Approach: _____ • Prohibited Approach: _____	
Equipment ID: _____ Date: _____	

Figure 2

D. Motor Current-Time Characteristic Curves:

1. A complete independent set of current-time characteristic curves for all 480 volt motor drives indicating coordination between the protective relays and the thermal characteristics of the motor shall be provided.
2. The Contractor shall obtain from the motor supplier, the necessary information to perform the study. Certified curves for, "Safe time vs. current at 100 percent voltage," and "Accelerating time vs. current at 100 percent voltage," shall become part of the final report.

E. Motor Starting Study:

1. A motor starting study for all large electric drives to determine voltage dip or power inrush limitations at selected locations due to starting of motors shall be provided. This applies to both the normal and the emergency mode.

F. Generator Protective Devices:

1. The study shall address all of the protective devices provided for generator protection.
2. Protective relays requiring settings shall include, but not necessarily limited to:
 - a. Differential
 - b. Overcurrent with voltage restraint
 - c. Ground
 - d. Undervoltage
 - e. Reverse power
 - f. Unbalanced loading and open phase
 - g. Loss of excitation

G. General Information for Time-Current Curves Presentation:

1. The coordination plots shall include complete titles, representative one-line diagrams, legends, associated power company's relay or system characteristics, significant motor starting characteristics, complete parameters for power, and substation transformers, and complete operating bands for low-voltage circuit breaker trip devices.
2. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pickup settings required.

3. The short-time region shall indicate the medium voltage relay instantaneous elements, the magnetizing in-rush, and ANSI withstand transformer parameters, the low-voltage circuit breaker instantaneous trip devices, fuse manufacturing to tolerance bands, and significant symmetrical and asymmetrical fault currents.
4. Each primary protective device required for a delta-to-wye connected transformer shall be selected so that the characteristic or operating band is within the transformer parameters; which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line-to-ground faults.
5. Low-voltage power circuit breakers shall be separated from each other and the associated primary protective device, where feasible, by a 16 percent current margin for coordination and protection in the event of secondary line-to-line faults.
6. Protective relays shall be separated, where feasible, by a 0.3 second time margin when the maximum three-phase fault flows, to assure proper **selectivity**.

PART 2 - PRODUCTS (SECTION NOT USED)

PART 3 – EXECUTION (SECTION NOT USED)

END OF SECTION

SECTION 26 05 19
WIRES AND CABLES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish, install and test all wire, cable, and appurtenances as shown on the Drawings and as hereinafter specified.

1.02 SUBMITTALS

- A. Samples of proposed wire and cable shall be submitted for approval. Each sample shall have the size, type of insulation and voltage stenciled on the jacket.
- B. Installed, unapproved wire shall be removed and replaced at no additional cost to the Owner.

1.03 APPLICATIONS

- A. All power wire shall be THWN-2.
- B. Single conductor wire for control, indication and metering shall be type MTW No. 14 AWG, 19 strand or type THWN No. 14 AWG stranded.
- C. Wire for process instrumentation or shielded control cable shall be No. 16 AWG, shielded and stranded.
- D. Ethernet Unshielded Twisted Pair (UTP) Cable shall be Cat-6, yellow, Belden 1872 or approved equal.

1.04 MINIMUM SIZES

- A. Except for control and signal leads, no conductor smaller than No. 12 AWG shall be used.

PART 2 - PRODUCTS

2.01 MATERIALS

All wires and cables shall be of annealed, 98 percent conductivity, soft drawn stranded copper conductors. Type THWN shall be as manufactured by the Southwire Co., Collyer Insulated Wire Co., Rome Cable or approved equal.

2.02 INSTRUMENTATION AND CONTROL CABLE

- A. Process instrumentation wire shall be twisted pair, 600V, cross-linked polyethylene insulated, aluminum tape shielded, polyvinyl chloride jacketed, type "XLP" as manufactured by the American Insulated Wire Co., Eaton Corp. "Polyset," or

approved equal. Multi-conductor cables shall be supplied with individually shielded twisted pairs.

- B. Instrumentation shall be stranded, 600V, cross-linked polyethylene insulated with PVC jacket, type "XLP" as manufactured by the American Insulated Wire Co., Eaton Corp. "Polyset," or approved equal.

2.04 VARIABLE FREQUENCY DRIVE (VFD) OUTPUT POWER CABLE:

- A. Section applies to power cables routed between the output of VFD's and motor terminals.
- B. Cable shall be rated for 1000 volts and shall meet the requirements below:
 - 1. Conductors shall be stranded Class B bare copper.
 - 2. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
 - 3. Type of wire shall be XLPE RHH/RHW-2 rated 90 degrees C suitable for wet locations.
 - 4. Provide overall 5 millimeter metallic shield (copper tape shield) overlapped 50%.
 - 5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
 - 6. Cable construction shall consist of three insulated current-carrying phase conductors and three bare ground conductors, symmetrically placed between the phase conductors, and twisted beneath a continuous overall PVC polymeric jacket.
- C. Manufacturers:
 - 1. Belden
 - 2. Flex

2.05 Cat 6E Ethernet Cable.

- A. Cable shall be waterproof and suitable for underground duct banks. It shall meet the following requirements:
 - UV-resistant, gel-filled jacket.
 - Color coded in accordance with EIA 568.
 - Operating Temperature Range: -45 to +80 degrees C.
 - L-Com part no. TOC-5794.

2.05 TERMINATIONS AND SPLICES

- A. Power Conductors: Terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling.

- B. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors per termination. Termination on screw type terminals shall be made with a maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors. Heat shrink boots shall be utilized for all outdoor splices.
- C. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): Terminations permitted shall be typical of control conductors. Splices are allowed at instrumentation terminal boxes only.
- D. Except where otherwise approved by the Engineer no splices will be allowed in manholes, handholes or other below grade located boxes.
- E. Splices shall not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc.), conduit bodies, etc.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All conductors shall be carefully handled to avoid kinks or damage to insulation.
- B. Lubrications shall be used to facilitate wire pulling. Lubricants shall be U.L. listed for use with the insulation specified.
- C. Shielded instrumentation wire shall be installed from terminal to terminal with no splicing at any intermediate point.
- D. Shielded instrumentation wire shall be installed in rigid steel conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from control cables in manholes.
- E. Shielding on instrumentation wire shall be grounded at one end only, as directed by supplier of the instrumentation equipment.
- F. Wire and cable connections to terminals and taps shall be made with compression connectors. Connections of insulated conductors shall be insulated and covered. All connections shall be made using materials and installation methods in accordance with instructions and recommendations of the manufacturer of the particular item of wire and cable. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.
- G. All wire and cable shall be continuous and without splices between points of connection to equipment terminals, except a splice will be permitted by the Engineer if the length required between the points of connection exceeds the greatest standard shipping length available from the manufacturer specified or approved by the Engineer as the manufacturer of the particular item of wire and cable.
- H. Steel fish tapes and/or steel pulling cables shall not be used in PVC conduit runs.

- I. All control and instrumentation circuits and wiring shall be clearly and permanently numbered and labeled at each end so as to identify the location of the opposite end and the function of the circuit. Individual wires in a multi-wire circuit shall be identified with wire numbers. Labeling shall be in place prior to turnover of any equipment, system or sub-system to Owner.

3.02 TESTS

- A. All 600-volt wire insulation shall be tested with a meg-ohmmeter after installation. Tests shall be made at not less than 1,000 VDC. Refer to specification section 26 05 00 for additional testing requirements.
- B. These tests shall be witnessed by the Engineer or Owner representative. A written report shall be submitted to the engineer for review.

END OF SECTION

SECTION 26 05 26
GROUNDING SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code and as hereinafter specified and shown on the Drawings.

1.02 RELATED WORK

- A. Wire shall be as specified under Section 26 05 19.
- B. Conduit shall be as specified under Section 26 05 34.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Ground rods: Ground rods shall be copperclad steel 5/8-inch x 20 foot. Ground rods shall be Copperweld or be an approved equal product. Install ground grid as shown on the plans.

PART 3 - EXECUTION

3.01 GENERAL

- A. The service entrance equipment ground bus shall be grounded to the ground grid as indicated on the Drawings. The protecting conduits shall be bonded to the grounding conductor at both ends. The CONTRACTOR shall not allow the water pipe connections to be painted. If the connections are painted, they shall be disassembled and remade with new fittings.
- B. Ground bus in all distribution panelboard shall be connected to the service entrance equipment ground bus with a No. 1/0 conductor.
- C. The grounding wire shall, unless otherwise indicated on the drawings, be sized in accordance with Table 250-122 of the National Electrical Code, except that a minimum No. 12 AWG shall be used.
- D. Motors shall be grounded as specified in Section 26 26 50, Motors.
- E. Grounding electrodes shall be driven as required. Where rock is encountered, grounding plates may be used in lieu of grounding rods.
- F. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and similar items shall be grounded.

- G. Exposed connections shall be made by means of approved grounding clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A or approved equal. All buried connections shall be made by welding process equal to Cadweld.
- H. For reasons of mechanical strength, grounding conductors extending from the grounding grid to the ground buses of the service entrance equipment shall be No. 1/0 AWG.
- I. The grounding grid conductors shall be embedded in backfill material around the structures.
- J. All underground conductors shall be laid slack and where exposed to mechanical injury shall be protected by pipes or other substantial guards. If guards are iron pipe or other magnetic material, conductors shall be electrically connected to both ends of the guard.
- K. The CONTRACTOR shall exercise care to insure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

3.02 TESTS

- A. The Independent Testing Company shall test the ground resistance of the system by 3 point method fall of potential. All test equipment shall be provided by the testing company and approved by the Engineer. Dry season resistance of the system shall not exceed 5 ohms. If such resistance cannot be obtained with the system as shown, the CONTRACTOR shall provide additional grounding as directed by the Engineer, without additional payment. The Contractor shall submit all grounding system test results to the Engineer for review prior to energization.

END OF SECTION

SECTION 26 05 34

RACEWAYS AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

1.02 APPLICATIONS

- A. Except where otherwise shown on the Drawings, or hereinafter specified. The following describes the conduit requirements of the project:
 - 1. All exposed raceways shall be in aluminum conduit unless otherwise noted in 2 through 5 below.
 - 2. Underground conductors shall be installed in Schedule 80 PVC conduits.
 - 3. Conduit installed in "Corrosive" areas and chemical rooms shall be PVC schedule 80. Mounting hardware shall be non-metallic.
 - 4. Underground power conductors and fiber optic cable shall be installed in Schedule 80 conduits, unless otherwise noted.
 - 5. Where Schedule 80 PVC is used, all below grade elbows and risers to above grade shall be PVC coated aluminum fittings or painted with 2 coats of bitumastic. All elbows above grade shall be suitably grounded. Conduit spacers shall be provided for underground conduit installation.
- B. All conduit of a given type shall be the product of one manufacturer.
- C. Unless otherwise hereinafter specified or shown on the Drawings, all boxes installed outdoors shall be NEMA 4X 316 gauge stainless steel. All boxes installed indoors, not in corrosive areas, shall be aluminum construction NEMA 1 rated.
- D. Exposed switch, outlet and control station boxes and fittings shall be aluminum where installed in "noncorrosive" indoor areas, stainless steel where outdoors, and non metallic where installed in corrosive areas where located in NEMA 4.
- E. Concealed switch, outlet and control station boxes shall be pressed steel. Terminal boxes, junction boxes, pull boxes, etc., installed outdoors shall be NEMA 4X stainless steel. Boxes installed indoors in non corrosive areas shall be aluminum construction. NEMA rating for the PVC boxes shall be as shown on the drawings. Boxes installed in "corrosive" areas shall be non metallic. Hardware shall be 316 stainless steel.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rigid Metal Conduit

1. Rigid metal conduit shall be for use under the provisions of NEC Article 344.
2. Rigid aluminum conduit shall be 6063 alloy and shall be as manufactured by New Jersey Aluminum Corp., AFC Co., VAW of America, Inc., or approved equal.
3. PVC coated rigid steel conduit shall have a 1/50-in thick, polyvinyl chloride coating permanently bonded to hot-dipped galvanized steel conduit and an internal phenolic coating, and shall be plasti-bond 2" as manufactured by Robroy Industries, Triangle PWC Inc., Perma-Cote Industries, or approved equal.

B. Rigid Nonmetallic Conduit

1. Rigid nonmetallic conduit shall be for use under the provisions of NEC Article 352.
2. PVC conduit shall be rigid polyvinyl chloride Schedule 80 as manufactured by Carlon, An Indian Head Co., Kraloy Products Co., Inc., Highland Plastics Inc., or approved equal.

C. Liquidtight Flexible Metal Conduit, Couplings and Fittings

1. Liquidtight flexible metal conduit shall be for use under the provisions of NEC Article 350.
2. Liquidtight flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div., Anaconda American Brass Co., American Flexible Conduit Co., Inc., Universal Metal Hose Co., or approved equal.
3. Fittings used with liquidtight flexible metal conduit shall be of the screw-in type as manufactured by the Thomas and Betts Co., Crouse-Hinds Co., or approved equal.

D. Flexible Couplings

1. Flexible couplings shall be as manufactured by the Crouse-Hinds Co., Appleton Electric Co., Killark Electric Manufacturing co., or approved equal.

E. Boxes and Fittings:

1. Steel elbows and couplings shall be hot-dipped galvanized. An extra 40 mil PVC protective coating shall be provided when used with PVC coated steel conduit. Joints shall be tapped.

2. Conduit hubs shall be as manufactured by Meyers Electric Products, Inc., Raco Div., Appleton Electric Co., or approved equal. Conduit hubs shall be provided for all outdoor conduit terminations.
 3. Conduit wall seals shall be type WSK as manufactured by the O.Z. Electrical Mfg. Co., or approved equal.
 4. Conduit wall seals for cored holes shall be type CSML as manufactured by the O.Z./Gedney Co., or approved equal.
 5. Conduit wall and floor seals for sleeved openings shall be type CSMI as manufactured by the O.Z./Gedney Co., or approved equal.
 6. Conduit sealing bushings shall be O.Z./Gedney Type CSB or approved equal.
- F. Conduit Mounting Equipment:
1. In dry indoor areas, hangers, rods, backplates, beam clamps, channel, etc. shall be galvanized rigid steel.
 2. FRP channel, 316 and stainless steel hardware shall be used in areas designated "CORROSIVE" on the Drawings. Fiberglass channel shall be resistant to the chemicals present in the area in which it is used.
 3. Channel installed outdoors shall be 304 stainless steel with 304 stainless steel hardware.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. No conduit smaller than 3/4-inch electrical trade size shall be used, nor shall any have more than four 90 degree bends in any one run. Pull boxes shall be provided as required or directed. Minimum size in floor slabs shall be 3/4-inch.
- B. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.
- C. The ends of all conduits shall be tightly plugged to exclude dust and moisture while the sites are under construction.
- D. Conduit supports shall be spaced at intervals as required to obtain rigid construction, but in no case more than as required by the NEC.
- E. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with steel horizontal members and threaded hanger rods. The rods shall be not less than 5/8-inch diameter. Material type shall be as specified in Section 2.

- F. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the spot type shall be provided.
- G. All conduits on exposed work shall be run at right angles to and parallel with the surrounding walls and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run perfectly straight and true. Conduits not installed in this fashion shall be replaced.
- H. No unbroken run shall exceed 300 feet in length. This length shall be reduced by 75 feet for each 90 degree elbow.
- I. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.
- J. Conduit terminating in gasketed enclosures shall be terminated with conduit hubs.
- K. Conduit wall seals shall be used for all conduits penetrating walls below grade or other locations shown on the Drawings.
- L. Liquidtight flexible PVC conduit shall be used for all motor and transformer terminations and other equipment where vibration is present.
- M. Flexible couplings shall be used in hazardous locations for all motor and transformer terminations and other equipment where vibration is present.
- N. Conduit stub outs for future construction shall be provided with threaded PVC end caps at each end.
- O. Galvanized steel conduit entering manholes and below grade pull boxes shall be terminated with grounding type bushings and connected to a 5/8" x 10" rod with a #6 bare copper wire.
- P. Underground 120 volt circuits (GRS or Schedule 80 PVC) shall be installed directly to the respective distribution panelboard, lighting panels, etc. Stainless steel pull boxes shall be wall mounted on structures to eliminate excessive bends. With prior approval, below grade pull boxes, equal to Brooks #2424 (minimum), with hot dip galvanized covers and frames, may be used. Splices shall not be made in above or below grade pull boxes without prior approval.
- Q. All field cut threads on galvanized steel conduit shall be cleaned and painted with zinc-rich paint before installing.
- R. A 4-inch concrete conduit housekeeping pad shall be required for all exposed conduit stub-ups. This applies to ALL exposed conduits installed indoors or outdoors.
- S. Installation of PVC coated conduit shall be performed in accordance with the Manufacturer's installation manual. To assure correct installation, the installer shall

be certified by the Manufacturer to install coated conduit and provide a valid unexpired installer certification card.

- T. All clamping, cutting, threading, bending and assembly should be done in accordance with the manufacturer's recommendation.

3.02 CONDUIT IDENTIFICATION

- A. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, condulets, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:
 - 1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
 - 2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word "TO:" and the text in the 'TO' column of the conduit and wire schedule (e.g. TO: MCC-3). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word "FROM:" and the text in the 'FROM' column of the conduit and wire schedule (e.g. FROM: MCC-1). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.
 - 3. For conduits ¾" through 1½" in size, the text shall be a minimum 18 point font. For conduits 2" and larger, the text shall be a minimum 24 point font.
 - 4. Label height shall be ¾" minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
 - 5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.
 - 6. Labels shall be made of permanent vinyl with adhesive backing as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal. Labels made of any other material are not acceptable.
- B. Conduits that are not exposed but installed beneath free standing equipment enclosures shall be identified by means of a plastic tag with the following requirements:

1. The tag shall be made of white Tyvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
2. The tag shall be affixed to the conduit by means of a nylon cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.
3. Tags shall be White Tyvek as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal.

END OF SECTION

SECTION 26 05 43
UNDERGROUND SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install a complete underground system of ducts, manholes and handholes all as hereinafter specified and shown on the Drawings.

1.02 RELATED WORK

- A. Excavation and backfilling is included in Division 2.
- B. All concrete and reinforcing steel shall be included under Division 3.
- C. Conduit for ducts shall be as specified under Section 26 05 34.
- D. Ground rods and other grounding materials and methods shall be as specified under other Sections of Division 16.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Ducts shall be PVC type ductbank.
- B. Cable racks, supports, pulling-in irons, manhole steps, and hardware shall be stainless steel manufactured by Cope or approved equal. All hardware shall be 304 stainless steel or non metallic.
- C. Precast manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load. Precast manholes and handholes shall be as manufactured by Brooks Products Co., or approved equal.
- D. Handhole covers and frames shall be provided as required.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Ducts shall be installed to drain away from buildings; ducts between manholes or handholes shall drain toward the manholes or handholes. Duct slopes shall not be less than 3 inches per 100 feet.
- B. Duct banks shall be reinforced as shown on the Drawings.
- C. Duct lines shall be laid in trenches on a clean backfill bedding not less than 6

inches thick and well graded.

- D. Plastic spacers shall be used to hold ducts in place. Spacers shall provide not less than 2-inch clearance between ducts.
- E. The minimum cover for duct lines shall be 24 inches unless otherwise permitted by the Engineer.
- F. Duct entrances to buildings and structures shall be made with steel conduit not less than 10 feet long.
- G. PVC duct terminations at manholes shall be with PVC end bells. Steel conduits shall be terminated with insulated, grounding-type bushings.
- H. Where bends in ducts are required, long radius elbows, sweeps and offsets shall be used.
- I. All ducts shall be rodded and a mandrel drawn through followed by a swab to clean out any obstructions which may cause cable abrasions. The mandrel shall be 12 inches in length and the diameter 1/2 inch less than the inside diameter of the duct.
- J. Spare ducts shall be plugged and sealed watertight at all manholes, buildings and structures.
- K. Ducts in use shall be sealed watertight at all manholes, buildings and structures.
- L. Pulling-in irons shall be installed opposite all duct entrances to manholes, equal to Cope Cat. No. 311-9.
- M. Cable racks shall be cut to length for one, two, three or four vertical tiers of cables. Racks shall be mounted with 1/2 inch by 4 inch expansion bolts on manhole walls. Arms similar and equal to Cope Cat. No. 325-T4, 325-T75 and/or 325-T10 for one, two and/or three cables respectively shall be furnished and installed with Cat. No. 326-T22 porcelain insulators for support of cables. Lock clips shall be furnished and installed to secure hooks in position.
- N. Cables shall be trained in manholes and supported on racks and hooks at intervals not greater than 3 feet-0 inches and supports shall be installed on each side of all splices. Furnish inserts on all manhole walls for mounting future racks as well as racks required for present installation. Branch circuit conductors shall not be run in manholes.
- O. PVC coated rigid steel conduit shall be used for risers. For fiber runs, a fiber to PVC coated rigid steel conduit adapter shall be used at the lower end of the elbow and the elbow and all exposed conduit shall be PVC coated.
- P. All risers from underground shall be given a heavy coat of bitumastic paint from a point 1 foot-0-inch below grade to a point not less than 6 inches above grade or

surface of slab.

- Q. All joints shall be made so as to prevent the passage of concrete inside the conduit to form obstructions or cause cable abrasions.
- R. Manhole covers in streets shall finish flush with finished paving and in other areas shall finish 3 inches above crown of adjacent roadway. Floor elevations of manholes shall be so set that the center line of the lowest conduit entering will be not less than 1-foot above the floor and center line of the highest conduit entering will be not less than 1 foot below the roof slab.
- S. Concrete monuments shall be provided at each stubbed conduit location. Monuments shall be as shown on the Drawings and shall be installed in the same manner outlined for manhole covers.
- T. A #6 bare copper wire (stranded) shall be installed in each 4-inch PVC conduit.
- U. A 5/8-inch by 20-foot copperclad ground rod shall be driven in the bottom of each manhole. All bond wires and galvanized steel conduits shall be bonded to the ground rod.

END OF SECTION

SECTION 26 05 90

MISCELLANEOUS EQUIPMENT

PART 1- GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install all miscellaneous equipment as hereinafter specified and as shown on the Drawings.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Disconnect Switches:

1. Non-fusible disconnect switches shall be heavy-duty, NEMA type H, quick-make, quick-break, visible blades, 600 volt as shown on the drawings with full cover interlock. All current carrying parts shall be copper.
2. Enclosure type shall be NEMA 4X, 316 stainless steel with copper lugs except as otherwise shown on the Drawings.
3. Switches shall be horsepower rated as manufactured by the Square D Co., or approved equal.
4. Control wiring shall not pass through any disconnect enclosure. A junction box shall be provided, constructed of the same material as the disconnect, and utilized to separate power and control wiring prior to the disconnect enclosure.
5. Each disconnect shall be provided with a plastic nameplate, affixed to the enclosure without screws, identifying the equipment served.
6. Furnish and install nameplate for all disconnect switches including statement "Do Not Operate Under Load".

B. Control Stations:

1. Control stations shall be NEMA 4X stainless steel heavy-duty type, with full size operators when located outdoors, in "NEMA 4" locations or in "Corrosive" areas.
2. Control stations shall be Class 9001, manufactured by the Square D Company or approved equal.
3. Pilot lights shall be complete with glass jewels and 150 volt lamps.

- C. Unless otherwise noted, all NEMA 4 enclosures shall be 316 stainless steel. NEMA 4X push buttons and pilot lights shall be provided in all weatherproof control panels.
- D. Dry Type Step Down Transformers:
1. Transformers shall be dry type, two winding with KVA and voltage ratings as shown on the Drawings.
 2. Four full capacity taps shall be furnished, two 2 1/2% above and two 2 1/2% below rated primary voltage.
 3. Transformers shall be built in accordance with ANSI C89 and NEMA ST1 4 with a maximum insulation temperature rise of 115° C.
 4. Transformers shall be manufactured by the Square D Company, General Electric Co., or approved equal.
 5. Provide NEMA Type 2 transformers as shown in the Electrical Rooms.
- E. Control Relays:
1. Control relays shall be heavy duty machine tool type, with 10 ampere, 600 volt, convertible contacts. Time delay relays shall be pneumatic, adjustable 1/5 to 180 seconds.
 2. Relays shall be CR2810 and CR2820 as manufactured by the General Electric Co. or approved equal.
- F. Electrical Switchboard Matting:
1. The rubber matting shall provide a floor covering to prevent shock around high voltage electrical apparatus, fuse boxes, switchgear, control panels and heavy machinery.
 2. The matting shall meet current ASTM and ANSI (plus IEC Division of ANSI, Tech Committee-78) specifications for this material.
 3. The matting shall be 1/4-inch thick, Class 2 as manufactured by The Mat King, or approved equal.
 4. Provide floor sealant, suitable for electrical/control rooms.
- G. Detectable Polyethylene Warning Tape:
1. Warning tape shall be 5 mil red polyethylene film, 6 inch minimum width. Tape shall be capable of being detected by either conductive or inductive location techniques.
 2. Warning tape shall be Mutual Industries Part No. 17774 or equal.

H. Equipment Mounting Stands:

1. Mounting stands shall be custom fabricated from ¼ inch 316 stainless steel plate and 3-inch stainless steel channel, unless otherwise shown on the drawings.
2. All hardware shall be 316 stainless steel.

I. Break-Glass Emergency (Shunt Trip) Stations:

1. Break-Glass Emergency Station shall be of the break glass design with a weatherproof cast metal outer case finished in fire red and have an attached chain hung "Hammer". A glass panel shall be mounted in front of the push button operator. Switch contacts shall be 1-open, 1-closed, rated 10 amps, 600 Volts.
2. Emergency stations shall be NEMA 4X stainless steel heavy-duty type.

J. Magnetic Motor Starters:

1. Motor starters shall be 2 or 3 pole, 1 or 3-phase as required, 60 Hz, 600 volt, magnetically operated, full voltage nonreversing except as shown on the Drawings. NEMA sizes shall be as required for the horsepower shown on the Drawings.
2. Two speed starters shall be for single or two winding motors as shown on the Drawings.
3. Each motor starter shall have a 120 volt operating coil, and control power transformer. Three phase starters shall have 3 overload relays. Auxiliary contacts shall be provided as shown on the Drawings or required.
4. Overload relays shall be non-adjustable, ambient compensated and manually reset.
5. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses.
6. Built-in control stations and indicating lights shall be furnished where shown on the Drawings.
7. Enclosure type shall be NEMA 1 except as shown on the Drawings.
8. NEMA Type 4 enclosures shall be stainless steel.
9. Magnetic motor starter shall be as manufactured by the Square D. Co., General Electric, Cutler Hammer/Westinghouse, Siemens, Allen Bradley.

K. Combination Magnetic Motor Starters:

1. Motor starters shall be a combination motor circuit protector and 3-pole, 60 Hz, 600 volt, magnetically operated, full voltage non-reversing contactor except as otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepower shown on the Drawings.
2. Two speed starters shall be for single or two winding motors as shown on the Drawings.
3. Each motor starter shall have a 120 volt operating coil and control power transformer. Three phase starters shall have 3 overload relays. Auxiliary contacts shall be provided as shown on the Drawings or required.
4. Overload relays shall be non-adjustable, ambient compensated and manually reset.
5. Built-in control stations and indicating lights shall be furnished where shown on the Drawings.
6. All enclosure type shall be NEMA 1, 316 stainless steel except as shown on the drawings.
7. NEMA Type 4 enclosures shall be stainless steel.
8. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be furnished with bolt-on current limiting fuses.
9. Combination magnetic motor starters shall be as manufactured by the Square D Co., Allen Bradley, Culter Hammer, GE.

END OF SECTION

SECTION 26 24 10

PANELBOARDS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor materials, equipment and incidentals required and install all panelboards as hereinafter specified and as shown on the Drawings.

PART 2 – PRODUCTS

2.01 RATING

- A. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.

2.02 STANDARDS

- A. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

2.03 CONSTRUCTION (NEMA 1)

- A. Interiors:
 - 1. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the antiturn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated.
 - 2. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.
 - 3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.
 - 4. A nameplate shall be provided listing panel type, number of circuit breakers and ratings.
- B. Buses:

1. Bus bars for the mains shall be of copper. Full size neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Cross connectors shall be copper.
2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.
4. Buses for 480V panelboards shall be rated for 65,000 amperes RMS symmetrical. Buses for 120/208V and 120/240V light and appliance panels shall be rated 10,000 amperes RMS symmetrical.

C. Boxes:

1. Recessed boxes shall be made from galvanized code gauge steel without multiple knockouts. Surface mounted boxes shall be painted to match the trim. Boxes shall be of sufficient size to provide a minimum gutter space of 4-inches on all sides.
2. Surface mounted boxes shall have an internal and external finish as hereinafter specified in paragraph D4.
3. At least four (4) interior mounting studs shall be provided.
4. All conduit entrances shall be field punched.
5. Panelboards installed in the Process Building Pump Room covered area shall be NEMA 4X 316 stainless steel. Panelboards installed in the Electrical Building shall be NEMA 1.

D. Trim:

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.
2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-inches in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Two keys shall be supplied for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.
3. The trims shall be fabricated from code gauge sheet steel.

4. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
 5. Trims for flush panels shall overlap the box by at least 3/4-inch all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.
 6. Panelboards shall be labeled to match drawings.
- E. Manufacturer:
1. 480V, 3-phase, 3-wire panelboards shall be A series II as manufactured by the GE Energy Industrial Solutions, Square D Co., I-Line, Cutler Hammer or Siemens.
 2. 120/240V, single phase, 3-wire, and 120/208V 3-phase, 4 wire panelboards shall be type NLAB as manufactured by the General Electric Company, Square D Co., Type NQOB, or approved equal.

2.04 CIRCUIT BREAKERS

- A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.
- B. Circuit breakers shall be molded case, bolt-in type.
- C. Circuit breakers used in 120/240-volt and 120/208-volt panelboards shall have an interrupting capacity of not less than 10,000 - amperes, RMS symmetrical.
- D. Three pole breakers used in 480V panelboards shall have an interrupting capacity of not less than 65,000 - amperes RMS symmetrical.
- E. GFCI (ground fault circuit interrupter) shall be provided for circuits where indicated on the Drawings. GFCI units shall be 1 pole, 120 volt, molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be U.L. listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time), and an interrupting capacity of 10,000 amperes RMS.

2.05 SURGE SUPPRESSORS

- A. All panelboards shall be equipped with surge suppressors.
- B. Surge suppressors used in 120/240V or 120/208V panelboards shall be APT XT series or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Boxes for surface mounted panelboards shall be mounted so there is at least 1/2-inch air space between the box and the wall.
- B. Unless otherwise noted on the Drawings, top of cabinets shall be mounted 6-feet 7-inches above the floor, properly aligned and adequately supported independently of the connecting raceways.
- C. All wiring in panelboards shall be neatly formed, grouped, laced, and identified to provide a neat and orderly appearance. A typewritten directory card identifying all circuits shall be placed in the cardholder inside the front cover.

END OF SECTION

SECTION 26 26 50

MOTORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install the motors as hereinafter specified and as called for in other sections of these Specifications.

1.02 QUALIFICATIONS

- A. Motor shall be sufficient size for the duty to be performed and shall not exceed their full-rated load when the driven equipment is operating at specified capacity. Unless otherwise noted, motors driving pumps shall not be overloaded at any head or discharge condition of the pump.

1.03 SUBMITTALS

- A. The motor manufacturer shall submit to the Engineer certified dimension prints showing nameplate data and outline dimensions within three weeks of the date they receive the order.
- B. Guarantee: All equipment furnished and installed under this Section shall be guaranteed against defects of workmanship, materials and improper installation for a period of one year from date of acceptance. All such equipment or parts proven defective, due to the above noted causes, shall be replaced in the machines by the Contractor at no expense to the Owner.
- C. Provide equipment warranty in accordance with Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 RATING

- A. Unless otherwise noted, all motors shall be of the low voltage type. All motors 1/2 through 100 horsepower shall be rated 230/460 volt, 3 phase, 60 Hertz A.C.; motors 125 horsepower through 500 horsepower shall be rated 460 volt, 3-phase, 60 Hertz, and motors below 1/2 horsepower shall be rated 115/230 volt, 1 phase, 60 Hertz A.C.

2.02 THREE PHASE INDUCTION MOTORS

- A. Motors 15 HP and larger shall have a 120-volt space heater for moisture control.

- B. Unless specifically noted in other sections of these Specifications, all motors shall have a minimum as indicated in the table below. All motors shall be "premium efficiency" type.
- C. Motors operating with variable frequency drives shall state that they are suitable for their intended applications. Motor nameplate shall read "Inverter Duty Rated".

In addition, Motors operating with Variable Frequency Drives (VFDs) shall meet the requirements of NEMA MG1 Part 31.

TABLE 16150-1

Motor HP	Min. Eff.	Max. dba	Motor HP	Min. Eff.	Max. dba
1-2	84.0%	74	25-30	92.0%	92
3-5	86.5%	79	40-50	93.0%	97
7.5-10	90.2%	84	60-75	94.0%	100
15-20	91.0%	89	100	94.1%	102

- D. Motors 10 Hp and larger and motors and operating with a VFD shall have imbedded a winding temperature switch.
- E. Motors 300 Hp and larger shall have vibration protection and a bearing temperature switch.

2.03 CONSTRUCTION

A. General:

1. All drip-proof and weather protected Type I motors shall have epoxy encapsulated windings. Totally enclosed motors shall not be encapsulated. Motors not readily available with encapsulated windings may be standard type. Motors exposed to the outside atmosphere shall be totally enclosed fan cooled (TEFC) unless otherwise specified.
2. Squirrel-cage rotors shall be made from high-grade steel laminations adequately fastened together and to the shaft, or shall be cast aluminum or bar-type construction with brazed end rings.

B. Low Voltage, Three Phase Motors:

1. Motors shall be of the squirrel-cage or wound rotor induction type as noted. Horizontal, vertical solid shaft, vertical hollow shaft, normal thrust and high thrust types shall be furnished as specified herein. All motors shall be built in accordance with current NEMA, IEEE, ANSI and

AFBMA standards where applicable. Motors shall be of the type and quality described by these Specifications, fully capable of performing in accordance with manufacturer's nameplate rating, and free from defective material and workmanship.

2. Motors shall have normal or high starting torque (as required), low starting current (not to exceed 600 percent full load current), and low slip.
3. Motors shall be totally enclosed fan-cooled construction with 1.15 service factor unless otherwise noted. Indoor motors shall be WPI unless otherwise noted.
4. Motors shall be suitable for operation in moist air with hydrogen sulphide gas present.
5. The output shaft shall be suitable for direct connection or belt drive as required.
6. Motors shall have a Class B nonhygroscopic insulation system. Class F insulation may be used but shall be limited to Class B temperature rise.
7. All motors shall have a final coating of chemical resistant corrosion and fungus protective epoxy fortified enamel finish sprayed over red primer over all interior and exterior surfaces. Stator bore and rotor of all motors shall be epoxy coated.
8. All fittings, bolts, nuts, and screws shall be 316 stainless steel. Bolts and nuts shall have hex heads.
9. All machine surfaces shall be coated with rust inhibitor for easy disassembly.
10. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.
11. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.
12. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures will have stainless steel screen and motors shall be protected for corrosion, fungus and insects.
13. Low voltage, three phase motors shall be manufactured by General Electric, U.S. Motors, Westinghouse or approved equal.
14. Fractional Horsepower:

- a) Fractional horsepower motors shall be rigid, welded-steel, designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be reinforced, lightweight die-cast aluminum. Windings shall be of varnish-insulated wire with slot insulation of polyester film, baked-on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses and other hazards.
- b) Motor shaft shall be made from high-grade, cold-rolled shaft steel with drive-shaft extensions carefully machined to standard NEMA dimensions for the particular drive connection.
- c) For light to moderate loading, bearings shall be quiet all-angle sleeve type with large oil reservoir that prevents leakage and permits motor operation in any position.
- d) For heavy loading, bearings shall be carefully selected precision ball bearings with extra quality, long-life grease, and large reservoir providing 10 years' normal operation without relubrication.

15. Integral Horsepower:

- a) Motor frames and end shields shall be cast iron or heavy fabricated steel 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.
- b) Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.
- c) 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. Bearing journals shall be ground and polished.
- d) Rotors shall be made from high-grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel-cage windings may be cast-aluminum or bar-type construction with brazed end rings.
- e) Motors shall be equipped with vacuum-degassed antifriction bearings made to AFBMA Standards, and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without motor

disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of lubricant out of the bearing cavity.

- f) Bearings of high thrust motors will be locked for momentary upthrust of 30% downthrust. All bearings shall have a minimum B10 life rating of 100,000 hours in accordance with AFBMA life and thrust values.
- g) Vertical hollow-shaft motors will have nonreverse ratchets to prevent backspin.

C. Low Voltage, Single Phase Motors:

- 1. Single phase motors shall be split-phase and capacitor-start induction types rated for continuous horsepower at the rpm called for on the Drawings. Motors shall be rated 115/230 volts, 60 Hertz, single phase, open drip-proof, or totally enclosed fan cooled as called for on the Drawings, with temperature rise in accordance with NEMA Standards for Class B insulation.
- 2. Totally enclosed fan cooled motors shall be designed for severe-duty.
- 3. Motors shall have corrosion and fungus protective finish on internal and external surfaces. All fittings shall have a corrosion protective plating.
- 4. Mechanical characteristics shall be the same as specified for polyphase fractional horsepower motors.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Motor Connections: All motors shall be connected to the conduit system by means of a short section 18-inch minimum of flexible conduit unless otherwise indicated. For all motor connections, the Contractor shall install a grounding conductor in the conduit and terminate at the motor control center with an approved grounding clamp.

3.02 TESTS AND CHECKS

- A. The following tests shall be performed on all motors after installation but before putting motors into service.
 - 1. The Contractor shall megger each motor winding before energizing the motor, and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor. The following table gives minimum acceptable insulation resistance in megohms at various

temperatures and for various voltages with readings being taken after one minute of megger test run.

TABLE 16150-2

Degree Winding Temperature			Voltage		
F	C	115V	230V	460V	4,160V
37	3.9	60	108	210	1,700
50	10	32	60	120	1,000
68	20	13	26	50	460
86	30	5.6	11	21	195
104	45	2.4	4.5	8.8	84
122	50	1	2	3.7	35
140	60	.5	.85	1.6	15

2. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication, and shall lubricate if required in accordance with manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.
3. All motors shall be given the standard short commercial test prior to shipment. This shall consist of no load current, check current balance, winding resistance, air gap measurement, high potential tests, and bearing inspection. Six (6) copies of the certified short commercial test shall be mailed to the Engineer prior to shipment.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to furnish and install variable frequency drives as shown on the Drawings and as specified herein.
- B. 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 furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the variable frequency drives herein specified.

1.02 DESCRIPTION OF SYSTEM

- A. The variable frequency drives shall be furnished by the Division 26 CONTRACTOR and integrated into the control system by the SYSTEM SUPPLIER specified in 40 90 00. The CONTRACTOR is responsible for complete system operation and necessary coordination.
- B. The variable frequency drives will operate motors as specified in the pump section. The drives furnished herein under shall be totally compatible and adequately sized with the Motors to be supplied.
- C. The VFDs shall be of the Ultra Low Harmonic active front end type.
- D. Installation of the VFDs shall be provided as indicated on the electrical drawings. See E-5 for elementary schematic information.

1.03 QUALIFICATIONS

- A. Variable speed drives shall be sized to operate the ampacity shown on the electrical drawings. To assure unit responsibility, all equipment specified in this section of the specifications shall be furnished and coordinated by the CONTRACTOR. The CONTRACTOR shall be responsible for coordinating the sizing of all VFDs.
- B. The drives covered by these Specifications are intended to be equipment of proven ability as manufactured by reputable manufacturers having long experience in the production of identical units. The equipment furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.
- C. The variable frequency control shall operate satisfactorily when connected to a bus

supplying other solid state power conversion equipment which may be causing up to 10% total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other variable frequency drives are operated from the same bus.

Individual or simultaneous operation of the variable frequency drives shall not add more than 5% total harmonic voltage distortion to the normal bus, nor more than 10% while operating from standby generator (if applicable) per IEEE 519, latest edition. The load side of the main breaker shall be the point of common coupling (PCC). The short circuit current at point of common coupling under utility operation is approximately 50,000 Amps. A preliminary harmonic (voltage and current) analysis must be submitted by the variable frequency drive manufacturer at bid time, this must include all calculations, simply a statement of compliance is not acceptable. Compliance shall be verified by the variable frequency drive manufacturer with field measurements of the harmonic distortion difference at the point of common coupling with and without variable frequency drives operating. See testing requirements.

- D. The variable frequency drive manufacturer shall maintain and staff engineering service and repair shops through the United States, including the State of Florida, trained to do start up service, emergency service calls, repair work, service contracts and training of customer personnel.
- E. The variable frequency drives shall be as manufactured by:
 - a. ABB – ACQ880 series, Unitron Controls Representative.
 - b. Allen Bradley equivalent low harmonic active front end drive.

1.04 SUBMITTALS

- A. Copies of all materials required to establish compliance with the specifications shall be submitted. 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 the variable frequency drives. Data shall include certification that the variable frequency drives are warranted for use with the motors specified in Division 11 and Division 16.
 - 4. Complete drawings shall be furnished for approval before proceeding with manufacture and shall consists of master wiring diagrams, elementary or control schematics including coordination with other electrical control devices operating in conjunction with the variable frequency drive, and suitable outline drawings with sufficient details for locating conduit stub-ups

and field wiring. Generic schematics not specific to this project shall not be acceptable.

5. 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.

1.05 PRODUCT 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 spare parts must be properly protected against any damage during a prolonged 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. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.06 WARRANTY

- A. Five (5) - year on-site warranty shall be provided such that the owner is not responsible for any warranty costs including travel, labor, parts, or other costs for a full 5 years from the date of manufacture of the Drive. The warranty shall cover all Drive failures including line anomalies – including lightning strikes, load anomalies, accidental exposure to moisture or corrosives and accidental collision of other physical damage; product misapplications, vandalism and chronic problems due to the misapplication are not covered. The cost of the warranty shall be included in the bid.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The CONTRACTOR shall furnish and install complete variable frequency drive systems for. The CONTRACTOR is responsible for the start up of all VFD drives furnished on this project.
- B. The Contractor shall be responsible for the erection and installation of all equipment defined in this section of the contract documents.
- C. The variable frequency drive shall be comply with the latest applicable standards of ANSI, NEMA, IEEE, and the National Electric Code.

- D. Variable frequency drive shall operate as specified on standby generators or normal power sources.
- E. The CONTRACTOR shall provide a listing of all programmable parameters that are different from the factory default values. For each indicate:
 - 1. The factory default and meaning
 - 2. The revised value and meaning
- F. The CONTRACTOR shall provide a copy of PC compatible remote programming/diagnostic software and any required cables to the supplier of the control system. Refer to Division 13. The software shall be able to communicate to the VFDs via a RS485 and an ethernet network connection.

2.02 CONSTRUCTION

- A. Each variable frequency drive shall consist of a 460V, 3-phase rectifier, DC link and variable frequency inverter with features, functions and options as specified. The inverter shall be voltage source design using pulse width modulation (PWM) techniques.
- B. The variable frequency drives shall be rated for continuously operating at 1.15 times the full load current of the motor. The variable frequency drives shall be designed to provide continuous speed adjustment of three-phase motors. The variable frequency output voltage shall provide constant volts-per-Hertz excitation to the motor terminals up to 60 Hertz.
- C. Inverters shall be capable of converting incoming three phase, 460V (+10 to -10%) and 60 Hertz (+/-2) Hertz power to DC bus levels. The DC voltage shall be inverted to an variable frequency output.
- D. Controllers shall be rated for an ambient temperature of 0°C to 40°C and humidity of 0 to 95% non-condensing.
- E. VFDs shall have complete front accessibility. All VFD openings shall be filtered.
- F. The following standard basic control features shall be provided on the inverter:
 - 1. Start, Stop, "Power On" indicating light and speed control potentiometer. Terminations for remote mounted operator control devices shall be furnished.
 - 2. Unidirectional operation, coast to rest upon stop.
 - 3. Variable linear independent timed acceleration.
 - 4. Variable torque performance from 4 to 60 Hertz.

5. All variable frequency drives shall be furnished with 5% input power line reactors.
6. Frequency stability of 2% for 24 hours with voltage regulation of +2% of maximum rated output voltage.
7. LCD status indication for Power On, Run, Inverter Enable, Overcurrent, Overvoltage, Overtemperature, Low Supply, and Phase Loss.
8. 115V AC control power for operator devices.
9. Phase insensitive to input power.
10. Automatic restart upon return of power following a utility outage. Drive shall require manual reset after three (3) attempts in a 60 second period.

G. The following protective features shall be provided on the drive:

1. Input AC circuit breaker with an interlocked, pad lockable handle mechanism and AC input line current limiting fuses for fault current protection of AC to DC converter section and circuit breaker. Minimum short circuit rating of 65,000 AIC shall be provided.
2. Electronic overcurrent trip for instantaneous overload protection.
3. Undervoltage and phase loss protection of output.
4. -frequency protection.
5. Over-temperature protection.
6. Surge protection from input AC line transients.
7. Electrical isolation between the power and logic circuits, as well as between the 115V AC control power and the static digital sequencing.
8. Drive to be capable of withstanding output terminal line short or open circuits without component failure.
9. Units shall have an English language (no codes) alphanumeric diagnostic display. LED indication of over frequency, instantaneous overcurrent, DC over voltage, AC undervoltage/loss-of-phase, emergency stop, overload, over temperature, inverter pole trip and standby modes shall be provided and door mounted. Additional door mounted status indicating LEDs for self-diagnostic including run, phase loss, micro-processor fault, as well as board mounted LEDs including one for each inverter pole gating signal, each inverter pole status and each logic level VDC used. A comprehensive

microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions is also approved.

H. The following standard independent adjustments shall be provided on the inverter:

1. Minimum speed (12 to 54 HZ).
2. Maximum speed (40 to 60 HZ).
3. Acceleration time 6 to 60 Sec. (minimum).
4. Deceleration time 6 to 60 Sec. (minimum).
5. Volts per Hertz.
6. Stability adjustment, if required.
7. Voltage boost (100 to 600 percent of nominal V/HZ ratio at 1 HZ tapering to 100 percent at 20 HZ).

I. The following shall be furnished with each controller:

1. Isolated process instrument speed input signal of 4-20 mA DC.
2. Isolated process instrument speed output signal 4-20 mA DC.
3. Relay output auxiliary contacts as shown on the drawings or as required herein, in Division
4. Door-mounted output load ammeter, voltmeter, and speed output indicating meters.
5. Built-in self diagnostics.
6. Relay output auxiliary contacts as shown on the drawings.
7. Local/Off/Remote and Start/Stop selector switches.
8. Input line reactors.
9. All openings in the VFD shall be filtered.
10. Communications shall be EthernetIP.

J. Active Front End for Harmonic Mitigation:

1. The Ultra Low Harmonic construction of the VFD shall maintain current

distortion levels at the VFD's input terminals to levels at or below those listed in "Harmonic Control in Electrical Power Systems, IEEE Std. 519." The input current to the VFD shall have a total harmonic content less than 5% of full rated capability at the input terminals of the VFD on power system sized according to IEEE 519 at line voltage unbalance up to 3% and under all motor load conditions. All harmonic management devices must be internal to the VFD enclosure and supplied as a complete solution.

2. To maintain system integrity, the VFD must maintain UL519 compliance, at the input terminals of the VFD, without exception, with up to and including a 3% voltage imbalance, phase to phase.
3. The VFD shall have an active line supply unit which controls the waveform of the input current and reduces the low order harmonic current drawn from the power line. Line currents and voltages shall be nearly sinusoidal. IGBTs shall be used in the rectifier and inverter circuits.
4. Each input phase of the VFD shall incorporate a symmetrical LCL filter arranged in a T- configuration. The inductors are to be series power components that carry the full current of the VFD. Internally built with in the input section of the VFD to prevent high level harmonics
5. The VFD shall operate at fundamental power factor 1.0 on the supply side under all motor load conditions. The input power factor shall be programmable from 0.8 lagging to 0.8 leading, allowing the VFD to be used as a compensating device for installations that are excessively inductive or excessively capacitive in reactive power.

- K.** Stand-alone variable frequency drive enclosures shall be NEMA Type 1, gasketed, filtered, freestanding floor-mounted, force ventilated (with replaceable air filters) construction requiring front access only. Variable frequency drives requiring rear access for any maintenance are not acceptable. The cooling air required to dissipate heat generated by the power electronics shall be isolated from all drive electronics. Variable frequency drives using liquid-cooled assemblies in conjunction with associated pumps, piping, and separate remote mounted exchangers are not acceptable. The inverters and converters shall have complete unobstructed front accessibility with easily removable assemblies. The complete enclosure shall maintain a constant height, width and depth. The height for all floor-mounted enclosures shall be maximum 90" high.

PART 3 - EXECUTION

3.01 INSTALLATION

- A.** Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Field wiring shall be in accordance with manufacturer's recommendations. Anchor bolts shall be stainless

steel and set in accordance with the manufacturer's recommendations.

3.02 SHOP PAINTING

- A. Prior to shop painting, all surfaces shall be thoroughly cleaned, dry, and free from all mill/scale, rust, grease, dirt, and other foreign matter.
- B. Drives shall be shop painted.

3.03 TESTING

- A. Tests and Check
 - 1. The drive manufacturer shall test the drive controller with a motor load prior to shipment. The motor shall have equal or greater full load current than the specified motor.
 - 2. A certified copy of all tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner.
- B. The SYSTEM SUPPLIER shall provide the services of a competent and experienced equipment manufacturer's factory field engineer to supervise start-up and provide training to the Owner's personnel. The factory field engineer shall be available for one (1) - eight (8) hour day to inspect the installed equipment and supervise the start-up demonstration and testing as specified in Section 01650: Start-up, and additional testing and training as specified herein. The factory field engineer shall be available for two (2) additional eight (8) hour days (a total of three (3) - eight (8) hour days) to provide factory and on-site training to the Owner's personnel as specified herein. Training of the Owner's personnel will only be considered valid for approval by the Engineer if it takes place after the successful start-up and demonstration test.

3.04 TRAINING

- A. The training and instruction shall be directly related to the System being supplied.
- B. The Supplier shall provide classroom training detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
- C. The Supplier shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.
- D. The training program shall represent a comprehensive program covering all aspects of the variable frequency drive and maintenance of the system.
- E. All training schedules shall be coordinated with, and at the convenience of the

Owner. Shift training may be required to correspond to the Owner's working schedule.

- F. Factory Training: Factory training shall be conducted before the System is commissioned, and subsequent to final manual submittals. Two days of factory training shall be provided and consist of schooling and hands on experience for two people covering the following:
 - 1. Theory of Operation
 - 2. Use of Software
 - 3. Troubleshooting
- G. On-site Training: On-site (field) training shall be conducted at the Owner's Plant Site and shall provide detailed hands-on instruction to Owner's personnel covering: system debugging, program modification, trouble-shooting, maintenance procedures, calibration procedures, and system operation.

END OF SECTION

SECTION 26 32 13

DIESEL ENGINE DRIVEN GENERATOR WITH WEATHERPROOF ENCLOSURE

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to install, put into operation, and field test the weatherproof enclosed diesel engine driven generator unit and appurtenances as shown on the Drawings and specified herein.
- B. 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 as offered. It is, however, intended to cover the furnishing, the shop testing, and delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete units as herein specified, whether specifically mentioned in these specifications or not.
- C. For the unit, there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. This installation shall incorporate the highest standards for the type of service shown on the Drawings. The Contractor is responsible for field testing of the entire installation and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.
- D. The generator shall communicate to the PLC control system via Ethernet IP over CAT 6 cable. Protocol converter shall be installed in the generator enclosure as required.

1.02 DESCRIPTION OF SYSTEMS

- A. The engine-generator set shall be mounted as shown on the Drawings and shall be arranged for automatic starting and stopping, and load transfer upon failure of the normal source of power. The unit controls shall provide for automatic exercising on a weekly basis.

1.03 QUALIFICATIONS

- A. The engine-generator set shall be the standard product, as modified by these specifications, of a Manufacturer regularly engaged in the production of this type of equipment. The unit to be furnished shall be of proven ability and shall be designed, constructed, and installed in accordance with best practices and methods. To qualify as a Manufacturer, the engine must be the principal item manufactured and the completed engine generator set shall be supplied by the Manufacturer's authorized distributor only. The distributor shall have a minimum of ten (10) years experience in the field of power generation.

- B. It is the intent of this specification to secure an emergency generator system that has been prototype tested, factory built, production tested, site tested and of the latest commercial design, together with all accessories necessary for a complete installation as shown on the plans and drawings, and specifications herein. The equipment supplied and installed shall meet the requirements of the NEC, along with all applicable local codes and regulations. All equipment shall be new, of current production of a national firm which manufactures the engine/generator and controls, transfer switch, and assembles the emergency generator system as a matched unit so that there is one-source responsibility for warranty, parts, and service through a local representative with factory-trained servicemen.
- C. The unit must be of such physical dimensions as to make a good installation in the opinion of the Engineer, in the space provided as indicated on the Drawings.
- D. The unit shall be assembled in the U.S. with over 50% of the components such as the engine, generator, auxiliary equipment, etc., manufactured in the U.S. by a Manufacturer currently engaged in the production of such equipment.
- E. The unit shall be shipped to the jobsite by an authorized engine distributor having a parts and service facility within a 50 mile radius of the jobsite. In addition, and in order not to penalize the Owner for unnecessary or prolonged periods of time for service or repairs to the emergency system, the bidding generator set supplier must have no less than eighty percent (80%) of all engine replacement parts locally available at all times. Certified proof of this requirement shall be furnished to the Engineer upon request.
- F. All materials and parts comprising the units shall be new and unused, of current manufacture, and of the highest grade, free from all defects or imperfections. Workmanship shall conform to the best modern practices. Only new and current models will be considered. The units offered under these Specifications shall be the product of a firm regularly engaged in the production of engine-generator equipment and shall meet the requirements of the Specifications set forth herein. Major exceptions to Specifications will be considered sufficient cause for rejection of the machines.
- G. The Engine/Generator Unit shall be as manufactured by Kohler, Caterpillar, Cummins Southeaster Power, ACF Standby Systems.

1.04 SUBMITTALS

- A. Submittal shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required for interconnection between the generator set, the transfer switch, and the switchgear panels included elsewhere in these specifications.

- B. The successful bidder shall submit to the Engineer for review in accordance with other sections, complete sets of installation drawings, schematics, and wiring diagrams which shall show details of installation and connections to the work of other Sections, including foundation drawings showing location and size of foundation bolts for the spring type vibration isolators and brochures covering each item of equipment.
- C. 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.
- D. The submittal data for the engine/generator set and weatherproof enclosure shall include, but not necessarily be limited to, the following:
 - 1. Installation drawings showing plan and elevations of the complete generator unit; foundation plan; exhaust silencer; starting battery; battery charger; weatherproof enclosure and base mounted fuel tank.
 - 2. Engine Data:
 - a) Manufacturer
 - b) MODEL
 - c) Number of cylinders
 - d) RPM
 - e) Bore x stroke
 - f) BMEP at full rated load
 - g) Piston speed, FPM
 - h) Make and model and descriptive literature of electric governor (where required)
 - i) Fuel consumption rate curves at various loads
 - j) Engine continuous pump drive duty rating (without fan) HP
 - k) Gross engine horsepower to produce generator standby rating (including fan and all parasitic loads) HP
 - 3. Generator Data:
 - a) Manufacturer
 - b) Model

- c) Rated KVA
 - d) Rated SKVA
 - e) Rated kw
 - f) Voltage
 - g) Temperature rise above 40 degree C ambient
 - 1) Stator by thermometer
 - 2) Field by resistance
 - 3) Class of insulation
 - h) Generator efficiency including excitation losses and at 80 percent power factor.
 - 1) Full load
 - 2) 3/4 load
 - 3) ½ Load
4. Generator Unit Control Data:
- a) Actual electrical diagrams including schematic diagrams, and interconnection wiring diagrams for all equipment to be provided. Standard preprinted sheets are not acceptable.
 - b) Legends for all devices on all diagrams.
 - c) Sequence of operation explanations for all portions of all schematic wiring diagrams.
5. Engine/Generator Unit and Weatherproof Enclosure: Dimensional data shall be given for the Engine/Generator set and for the weatherproof enclosure.
- a) Weight of skid mounted unit
 - b) Overall length
 - c) Overall width
 - d) Overall height
 - e) Exhaust pipe size

- f) CFM of air required for combustion and ventilation
- g) Heat rejected to jacket water and lubricating oil BTU/hr.
- h) Heat rejected to room by engine and generator BTU/hr.
- i) Weatherproof enclosure details and certification of manufacturing method per specifications.
- j) Base fuel tank, venting, fuel connection points and fill cap location.
- k) Data on all miscellaneous items supplied.

6. Optional System Service Contract:

- a) Equipment Supplier Company

Name
Address
City/State
Phone Number

- b) Attach the number of copies required of System Service Contract to submittal.

7. Furnish the number of copies required of the Manufacturer's certified shop test record of the complete engine driven generator unit.

8. Warranty information.

E. Submit to the Engineer operating and maintenance data.

F. Submit to the Engineer the equipment Manufacturer's Certificate of Installation, Testing, and Instruction.

G. Submit to the Engineer the written warranty as required in Paragraph 3.05 below.

1.05 TESTING

A. To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.

B. Design Prototype Tests: Components of the emergency system such as the engine/generator set, automatic transfer switch, and accessories shall not be subjected to prototype tests since the tests are potentially damaging. Rather, similar design prototypes and pre-production models, which will not be sold, shall

have been used for the following tests. Prototype test programs shall include the requirements of NFPA 110 and the following:

1. Maximum power (KW).
 2. Maximum motor starting (KVA) instantaneous voltage dip.
 3. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-2240 and 16.40.
 4. Governor speed regulation under steady-state and transient conditions.
 5. Voltage regulation and generator transient response.
 6. Fuel consumption at 1/4, 1/2, 3/4, and full load.
 7. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
 8. Three-phase short circuit tests.
 9. Alternator cooling air flow.
 10. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
 11. Endurance testing.
- C. Final Production Tests: The generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
1. Single-step load pickup.
 2. Transient and steady-state governing.
 3. Safety shutdown device testing.
 4. Voltage regulation.
 5. Rated power.
 6. Maximum power.
 7. Upon request, arrangements to either witness this test will be made, or a certified test record will be sent prior to shipment.
- D. Site Tests: An installation check, start-up and building load test shall be performed by the Manufacturer's local representative. The Engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:

1. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the Manufacturer's recommendations, under the environmental conditions present and expected.
2. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery charger, generator strip heaters, remote annunciator, etc.
3. Start-up under test mode to check 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.
4. Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test. An external load bank shall be connected to the system if sufficient building load is unavailable to load the generator to the nameplate KW rating.

1.06 SPECIAL TOOLS AND SPARE PARTS

- A. The Manufacturer shall furnish two (2) complete spare replacement sets of all filter elements required for the generator unit.

PART 2 - PRODUCTS

2.01 RATINGS

The standby rating of the generator set shall not exceed the Manufacturer's published prime rating by more than 10%. The gross engine horsepower required to produce the standby rating shall not exceed the Manufacturer's published continuous duty rating by more than 150 percent. Continuous duty rating shall be as defined in BS649 or DIN6270 but in no case shall it exceed the Manufacturer's published continuous duty rating for the engine as used in continuous rated pump drive applications. The gross engine horsepower required for the generator set standby rating described above shall include all parasitic demands such as generator inefficiencies, fuel pumps, water pumps, radiator fan (for fan cooled models) and all accessories necessary to the unit's proper operation while operating at rated load and at a rotative speed not to exceed 1800 rpm.

- B. The diesel engine driven generator set shall be capable of producing the specified standby kw rating for continuous electrical service during interruption of the normal utility source and shall be certified to this effect by the Manufacturer for the actual unit supplied.

C.

- D. The Diesel Engine/Generator Unit shall be rated for a minimum of 500KW (277/480 volts, 3-Phase, 60 Hertz) at 0.8 power factor with fan. The engine/generator set shall be suitable for all interruptible rate power schedules at rated KW without deviation. This shall include interrupting durations of any length. The Generator shall be suitable for starting and running the following loads:

Step# Load Description

1	30KVA Lighting and Receptacle load
2	50HP Misc Motor Load (Across the line)
3	200HP High Pressure Pump (VFD)
4	75HP Low Pressure Pump (VFD)
5	75HP Low Pressure Pump (VFD)

- E. Manufacturer shall submit generator sizing load calculations as part of the generator shop drawing submittal.

2.02 ENGINES

- A. The engine shall be full compression ignition, four cycle, single acting, solid injection engines, either vertical or "V" type. Speed shall not exceed 1800 revolutions per minute at normal full load operation. The engine governor shall be electronic type with a +/- 0.5 percent accuracy. Governor shall be by Woodward, Barber Coleman or Cummins EFC.
- B. The engine shall be capable of satisfactory performance on No. 2 fuel oil (ASTM Designation D396). Diesel engines requiring a premium fuel will not be considered.
- C. The engine shall be capable of operating at light loads for extended periods of time and shall provide a means to reduce carbonization. Periodic cleaning of exhaust ports shall not be required.
- D. The engine shall be equipped with fuel filters, lube oil filters, intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, service meter, engine driven water pump, and unit mounted instruments. Unit mounted instruments shall include a fuel pressure gauge, water temperature gauge, and lubrication oil pressure gauge. The engine shall be provided with low oil pressure, high water temperature, and low coolant level and overspeed safety shutdowns of the manual reset type. Additional instruments and safety shutdowns shall be provided as noted herein.
- E. Injection pumps and injection valves shall be a type not requiring adjustment in service and shall be of a design allowing quick replacement by ordinary mechanics without special diesel experience. The engines shall have an individual mechanical injection pump and injection valve for each cylinder, any one of which may be removed and replaced from parts stock. Fuel injection pumps shall be positive action, constant-stroke pumps, activated by a cam driven

by gears from the engine crankshaft. Fuel lines between injection pumps and valves shall be of heavy seamless tubing.

- F. The fuel system shall be equipped with fuel filters having replaceable elements. Filter elements shall be easily removable from their housing for replacing without breaking any fuel line connections, or disturbing the fuel pump, or any other part of the engine. All fuel filters shall be conveniently located in one accessible housing, ahead of the injection pumps so that the fuel will have been thoroughly filtered before it reaches the pump. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection valve assemblies. The engines shall be equipped with a built-in gear-type, engine-driven fuel transfer pump, capable of supplying fuel through the filters to the injection pump at constant pressure.
- G. In addition to the standard fuel filters provided by the engine Manufacturer, there shall also be installed a primary fuel filter and a water separator in the fuel inlet line to the engine.
- H. The engine shall be provided with removable wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness as required for maximum liner life. The cylinder block shall be a one piece stress relieved gray iron casting.
- I. The engine shall have a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings, valve rocker mechanism and governor. Effective lubricating oil filters shall be provided and so located and connected that all oil being circulated is continuously filtered and cleaned. Filters shall be accessible, easily removed and cleaned and shall be equipped with a spring-loaded by-pass valve as an insurance against stopping of lubricating oil circulation in the event the filters become clogged. The engine shall have a suitable water cooled lubricating oil cooler.
- J. The engine shall be provided with one or more engine mounted dry type air cleaners of sufficient capacity to protect effectively the working parts of the engine from dust and grit.
- K. During each initial start of the engine, a system shall be provided to pre-lube at low idle speed. When the internal oil pressure reaches a predetermined safe value, the engine will then increase to generator set operation speed.
- L. Mounting: The unit shall be mounted on a structural steel sub-base and shall be provided with spring type vibration isolators.
- M. The engine shall meet the requirements of EPA Tier 2.

2.03 COOLING SYSTEMS

- A. The engine shall be furnished with a unit mounted radiator-type cooling system having sufficient capacity for cooling the engine when the diesel generator set is

delivering full rated load in an ambient temperature not to exceed 120 degrees F. The radiator shall have heresite-coated core and galvanized steel structural frame to protect against corrosive environments. The engine shall be provided with a thermostatic valve placed in the jacket water outlet between the engine and the cooling source. This valve shall maintain the proper jacket water temperature under all load conditions. Total air restriction from the radiator shall not exceed 0.5 inches of water at both inlet and outlet. A flexible connecting section shall be provided between the radiator and discharge louver frame.

- B. Closed circuit jacket water systems shall be treated with a rust inhibitor as recommended by the engine Manufacturer.
- C. Provide one (1) unit mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water at minimum of 70 degrees F. The heater shall be 480-volt, single phase, 60 Hertz, size as required to achieve above noted ambient.
- D. The expansion tank of the radiator shall be fitted with a low water level switch and wired into the safety shutdown system of the unit.

2.04 FUEL LEVEL/LEAK MONITORING EQUIPMENT

- A. General
 - 1. Furnish and install three (3) fuel level float switches. Two (2) switches shall be located in the main tank for high and low fuel level monitoring and one (1) shall be located in the secondary tank for fuel leak detection. The generator control panel shall provide audible and dry contact alarm output for tank leak alarm. Switches shall be factory pre-wired to generator control panel.

2.05 GENERATOR, EXCITER AND ACCESSORIES

- A. Rating: The generator shall be rated 500KW, 0.8 p.f., 1800 RPM 3 phase, 60 Hertz, 277/480 volts, 12 leads, extended stack, with a maximum temperature rise of 105 degrees C (both armature and field) by resistance at full rated load in ambient air of 40 degrees C. The generator shall conform to NEMA Standard MG-1.
- B. Performance: The instantaneous voltage dip shall not exceed 20 percent of rated voltage when full load, at rated power factor, is suddenly applied. Recovery of stable operation shall occur within 5 seconds. Steady state modulation shall not exceed +1/2 percent.
- C. Construction:
 - 1. The generator and exciter shall be drip proof, with split sleeve, or ball race bearings. A shaft-mounted brushless exciter shall be a part of the assembly. The stator core shall be built up of high grade silicon steel

laminations precision punched, and individually insulated. Armature lamination followers and frame ribs shall be welded integral with the frames for support of the stator core. A directional blower shall be mounted on the unit to draw cooling air from the exciter and over the rotor poles and through louvered openings on the opposite end.

2. The exciter shall be a fast response type, with a rotating 3-phase full-wave bridge. The exciter shall have a low time constant and large capacity to minimize voltage transients under severe load changes.
3. Generator stator and exciter stator windings shall be a full Class H insulated system with Class F temp rise, vacuum impregnated with epoxy resin which after curing shall have additional treatment of epoxy for resistance to an environment of moisture and salt air. Generator coils shall be random or machine wound, and precision made, with turn-to-turn and ground insulation of glass yard and mica materials. The average di-electric strength for the form wound coils of the ground and end turn insulation shall not be less than 400 volts per mil. Spacers shall be tightly secured between end turns, and the end turn assembly securely lashed to the support rings.
4. Generator rotor poles shall be built up of individually insulated silicon steel punchings. Poles shall be wound and bonded with high strength epoxy resin. Cage connections to the amortisseur rings shall be brazed for strong construction and permanent electrical characteristics. Each pole shall be securely bolted to the rotor shaft with bolts sized for the centrifugal forces on the rotor. Generator windings shall be braced for full line to ground fault currents, with solidly grounded neutral system.

D. Accessories and Attachments

1. Low Voltage Terminal Boxes: The generator shall have separate AC and DC low voltage terminal boxes with suitably numbered terminal strip for required connections.
2. All required P.T.'s, C.T.'s and protective relays shall be supplied by the engine-generator Manufacturer as required.
3. Space Heater: Space heater shall be installed on the generator frame to maintain temperature of the entire generator above the dew point while not in use. Power supply shall be 120 volts single phase. Heater will be automatically disconnected when engine starts. The magnetic starter for the heaters shall be mounted in the terminal box. Furnishing and installation of control and starter to be by engine/generator supplier.

E. Generator Associated Controls:

1. Voltage Regulator:

- a) The generator Manufacturer shall furnish a hermetically sealed, silicon controlled rectifier type voltage regulator employing a zener reference with a +1 percent regulation for the generator. The regulator shall include 3-phase voltage sensing, automatic short circuit protection and shall include automatic under frequency protection to allow the generator to operate at no load at less than synchronous speed for engine start-up and shutdown procedures. Switches and/or fuses shall not be used to provide this protection. An over-voltage sensing module with manual reset shall be furnished with the regulator. A volts per Hz., sensing module shall be provided as part of the regulation system.
 - b) A voltage adjustment rheostat for 5 percent voltage adjustment on the unit shall be provided.
 - c) High voltage step-down potential transformers shall be provided for the voltage regulator power input and sensing circuits if required.
2. Sustained Short Circuit: A permanent magnetic exciter shall be provided on the unit for sustaining a current of 300 percent during a short circuit, permitting the generator breaker to trip on overload. To prevent possible overheating of the armature windings, appropriate relaying shall be supplied to limit the fault to ten seconds. All current transformers required shall be supplied by the switchgear Manufacturer.

2.06 WEATHER-PROTECTIVE ENCLOSURE

- A. The generator set shall be provided with a skin tight-non walk in sound-attenuated aluminum construction housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 74 dBA at any location 23 feet from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
- B. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and pad lockable door latches shall be provided for all doors. Door hinges shall be stainless steel.
- C. The enclosure shall be provided with an exhaust silencer which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a raincap and rainshield.

- D. The enclosure shall be primed for corrosion protection and finish painted with the Manufacturer's standard color. All surfaces of all metal parts shall be primed and painted.
- E. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
- F. The enclosure, including its installation on the sub base fuel oil tank, shall be certified by a Professional Engineer (P.E.) licensed in the State of Florida to be design rated for a wind load resistance up to 140 MPH. Provide two (2) original and six (6) copies the P.E. stamped certified wind load calculations report indicating compliance to the Owner's representative. The enclosure wind load rating is to be included on the Manufacturer's enclosure drawings

2.07 FUEL SYSTEM

- A. Base and Mounting - The generator set and enclosure shall be mounted and shipped to the jobsite on the formed steel sub-base provided by generator supplier. Provisions for crane unloading of the complete package shall be designed into the base of the unit.
- B. The base and enclosure assembly shall allow room within the package to mount and maintain the specified battery charger, engine starting batteries, racks, and cables, main line circuit breaker, and engine-generator control panel, and other items as specified or as shown on the drawings.
- C. The weight of the entire unit consisting of generator set, base, enclosure, and all other specified items including all liquids (i.e., fuel oil, lube oil, and cooling water) shall be calculated by the Manufacturer. The base of the unit shall be designed and manufactured as a heavy duty, formed steel construction with four (4) point lifting provision to support the calculated weight. Details and Manufacturer's certification of the base construction shall be included with the drawings submitted for approval as well as all weight calculations.
- D. Base Tank - The unit shall be equipped with a double wall in-base UL142 fuel tank of 3000 gallon minimum capacity and shall be supplied with a lockable, exterior located fill cap. All necessary fuel and vent lines with vent caps for proper engine performance shall be provided as well as a means to readily detect the fuel level in the tank without the use of a measuring stick.
- E. The fuel tank base maximum length & width dimensions shall be as noted on the drawings and be formed from steel of a minimum metal thickness of 0.25-inch (1/4-inch) and shall be fitted with low fuel level inner wall leak alarm contact for local and remote annunciation. The fuel tank height shall not exceed 30 inches.

- F. Filter/Separator- In addition to the standard fuel filters provided by the engine Manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine. The filter shall be a Racor simplex or duplex Model 1000, as required for proper fuel flow. It shall be supplied and installed by the enclosure supplier.

2.08 EXHAUST SYSTEM

- A. Exhaust Silencer - A critical type, side inlet, end outlet, GT Exhaust 201-5100 Series, Maxim M-51, Nelson, or Silex JB silencer and a flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the Manufacturer's recommendation. Mounting shall be provided by the Contractor as required. The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine Manufacturer.
- B. The silencer shall be fitted with a tail pipe extension terminating at a 45° angle to prevent the entrance of rainwater. It shall also be fitted with an expanded metal bird screen.
- C. Rain Skirt - At the point where the exhaust pipe flexible tubing penetrates the roof of the enclosure, a suitable "rain skirt" and collar shall be provided by the Manufacturer. It shall be designed to prevent the entrance of rain and allow for expansion and vibration of the exhaust piping without chafing or stress to the exhaust system. This detail must appear on the drawings submitted for approval.

2.09 AUTOMATIC STARTING SYSTEM

- A. Starting Motor - A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be 12 volts.
- B. Automatic Control - Fully automatic engine start-stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, overcrank, and loss of engine coolant. Alarms for approaching high water temperature and impending low oil pressure shall also be included. Controls shall include a 45-second single cranking cycle limit with lockout or a cyclic crank system with lockout and overcrank protection.
- C. Batteries - A lead-acid storage battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be 12 volts, and the battery set shall be rated no less than 225 ampere hours. Necessary cables and clamps shall be provided. The batteries shall be located in the generator enclosure floor mounted adjacent to the generator.
- D. Battery Tray - battery tray shall be provided for the batteries and shall conform to NEC 480-7(b). It shall be constructed of fiberglass and so treated as to be

resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over of battery electrolyte shall be contained within the tray to prevent a direct path to ground.

- E. Battery Charger - A current-limiting, automatic 12 volt DC charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include NFPA-110 annunciation alarm outputs and battery fault indication to provide early warning of system faults. It shall also include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, digital DC ammeter, and DC voltmeter, and fused AC input and output. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than ten (10) amperes. Charger shall be wall mounting type in NEMA 1 enclosure, and U.L.1236 listed as a Battery Charger for Charging Engine-Starter Batteries. The charger shall be as manufactured by SENS NRG Series, or equal per NFPA 110 and U.L. 1236. The charger shall be mounted and wired within the enclosure for the generator set by enclosure Manufacturer.

2.10 MAIN LINE CIRCUIT BREAKER

- A. Type – Two (2) Main line, molded case 800-amp 100% rated circuit breakers shall be mounted upon and sized to the output of the generator shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions. The breaker shall include ground fault sensing that will provide an alarm to the generator control panel upon ground fault conditions.
- B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriters Laboratories, National Electric Manufacturers Association, and National Electrical Code.
- C. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.
- D. Circuit breaker shall have battery voltage operated shunt trip wired to safety shutdowns to open the breaker in the event of engine failure.
- E. Each circuit breaker shall be equipped with an auxiliary contact for remote annunciation of breaker position.
- F. The rating of each circuit breaker shall allow the starting of full generator SKVA.
- G. The circuit breaker enclosure, together with all specified circuit breakers, shall be designed for the specific generator set specified and be equipped with an isolated neutral conductor bus, rear copper stabs, or load cable lugs and be finish painted to match the generator set.

2.11 GENERATOR CONTROL PANEL

A. Generator Control. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. The generator set mounted control shall include the following features and functions:

1. Control Switches

- a) Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
- b) EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
- c) RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
- d) PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

2. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

- a) Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 0.5%.

- b) Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
- c) The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
- d) The control system shall log total number of operating hours,
- e) total kWh, and total control on hours, as well as total values since reset.
- f) Digital metering is required. The analog and digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.

3. Generator Set Alarm and Status Display.

- a) The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
 - 1) The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for function, color, and control action (status, warning, or shutdown).
 - 2) The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
 - 3) The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - 4) The control shall include an amber common warning indication lamp.

b) The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:

- 1) low oil pressure (alarm)
- 2) low oil pressure (shutdown)
- 3) oil pressure sender failure (alarm)
- 4) low coolant temperature (alarm)
- 5) high coolant temperature (alarm)
- 6) high coolant temperature (shutdown)
- 7) high oil temperature (warning)
- 8) engine temperature sender failure (alarm)
- 9) low coolant level (alarm or shutdown--selectable)
- 10) fail to crank (shutdown)
- 11) fail to start/overcrank (shutdown)
- 12) overspeed (shutdown)
- 13) low DC voltage (alarm)
- 14) high DC voltage (alarm)
- 15) weak battery (alarm)
- 16) low fuel-daytank (alarm)
- 17) high AC voltage (shutdown)
- 18) low AC voltage (shutdown)
- 19) under frequency (shutdown)
- 20) over current (warning)
- 21) over current (shutdown)
- 22) short circuit (shutdown)
- 23) over load (alarm)
- 24) emergency stop (shutdown)

- c) Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
- d) The control shutdown fault conditions shall be configurable for fault bypass.

4. Engine Status Monitoring:

- a) The following information shall be available from a digital status panel on the generator set control:
 - 1) engine oil pressure (psi or kPA)
 - 2) engine coolant temperature (degrees F or C)
 - 3) engine oil temperature (degrees F or C)
 - 4) engine speed (rpm)
 - 5) number of hours of operation (hours)
 - 6) number of start attempts
 - 7) battery voltage (DC volts)
- b) The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

5. Engine Control Functions:

- a) The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
- b) The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

- c) The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
- d) The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
- e) The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

6. Alternator Control Functions:

- a) The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
- b) Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.
- c) Controls shall be provided to individually monitor all three control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator

set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

- d) Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
- e) An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

7. Other Control Functions:

- a) The generator set shall allow network communication with the generator set control by remote devices. The control shall communicate all engine and alternator data, and allow starting and stopping of the generator set via the network in both test and emergency modes.
- b) A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

8. Control Interfaces for Remote Monitoring:

- a) The control system shall provide four programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate:
 - 1) Generator set operating at rated voltage and frequency
 - 2) Common Alarm-Provide one (1) common generator system output alarm for monitoring capabilities. Common alarm conditions shall be as follows:

- Low battery

- Fuel Leak Detection (Sub-base tank inner wall)
 - Generator Trouble
- 3) Common shutdown
- 4) Load shed command.
- b) A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
- c) A fused 10 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
- d) All generator status and alarm information shall be available over Ethernet for connection to PCVP-1 over CAT 6 cable. Provide an Modbus TCP/IP to Ethernet/IP protocol converter to interface with the Process Control Panel (PCP-1).

PART 3 – EXECUTION

3.01 SERVICES

- A. Furnish the services of a competent and experienced Manufacturer's field service technician who has complete knowledge of proper operation and maintenance of the equipment for a period of not less than two (2) days in two separate visits 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.
- B. At least one (1) of the two (2) days shall be allocated solely to the instruction of plant 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 during plant start-up and acceptance by the Owner.
- C. Three final copies of operation and maintenance manuals specified must be delivered to the Engineer prior to scheduling the instruction period with the Owner.

3.02 PAINTING

- A. The engine generator set and associated equipment shall be shop primed and finish coated in accordance with the Manufacturer's standard practice prior to shipment. An adequate supply of touch-up paint shall be supplied by the Manufacturer.

3.03 TESTING

- A. The engine-generator set shall be given the Manufacturer's standard factory load test prior to shipment.
- B. Prior to final acceptance of the generator set, all equipment furnished under this Section shall be field tested per NFPA 110 to show it is free of any defects and the generator set can operate satisfactorily under full load test using resistance type load banks (brine tanks not acceptable). Test shall be for four (4) continuous hours. Any defects which become evident at this time shall be corrected before acceptance.
- C. An all-in-place static alignment check of all rotating components shall be made prior to first start-up, after unit is secured in place and all final connections are made.
- D. A final alignment check and/or adjustment shall be made after the machine has run four (4) to six (6) hours with its normal connected load.
- E. Contractor to provide fuel for load bank testing. Contractor to provide full fuel tank upon completion and acceptance of load test.

3.04 SYSTEM SERVICE CONTRACT

- A. The supplier of the standby power system must provide a copy of and make available to the Owner his standard service contract which, at the Owner's option, may be accepted or refused. This contract will accompany documents, drawings, catalog cuts, specification sheets, wiring or outline drawings, etc., submitted for approval to the designing Engineer. The contract shall be for the complete services rendered over a period of one (1) year.

3.05 WARRANTY

- A. Equipment furnished under this Section shall be guaranteed against defective parts and workmanship under terms of the MANUFACTURER'S and dealer's warranty. But, in no event, shall it be for a period of less than five (5) years (comprehensive) from date of substantial completion and shall include labor, parts and travel time for necessary repairs at the job site. Submittal data received without written warranties as specified will be rejected in their entirety. Warranties requiring a deductible are not acceptable.
- B. Warranty shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
- C. Parts and labor - comprehensive
- D. All of the generator system equipment furnished shall be guaranteed against defects in material, parts, and workmanship. The generator system equipment warranty

and associated coverage shall be for a period of five (5) years (60 months). The warranty shall be comprehensive covering all furnished system equipment including, but not limited to, the complete generator sets, remote annunciation equipment, and furnished diesel fuel oil sub base tank system equipment. The warranty shall commence on the date of satisfactory completion of generator system startup and load bank testing on site, and shall include labor, parts, travel time, expenses and expendable items (lubricating oil, coolant, filters, and other service items made unusable by the defect) necessary for repairs at the job site. The furnished generator set batteries are considered a consumable item and shall be warranted against defects in material and workmanship for a period of two (2) years from generator set startup, with no prorating.

- E. The generator system supplier shall be directly capable, without subcontracting, and to be solely responsible to maintain and provide qualified Factory trained servicemen, the required stock and availability of replacement parts, technical assistance, and complete equipment warranty administration on direct behalf of the generator equipment Manufacturers. Subcontracting or rerouting of these services by the generator supplier is not acceptable. Generator Supplier written certification of compliance to the specified warranty requirements shall be included in the furnished generator system Submittals and equipment parts and operation manuals furnished to Engineer and Owner for review and approval.
- F. The generator system Submittals and furnished generator system parts, operation and maintenance manuals shall include written warranties and supporting documentation clearly indicating and certifying complete compliance by the generator supplier to provision to the Owner of these specified warranty requirements for all furnished generator system equipment.
- G. The generator system supplier's failure to furnish the specified warranty coverage for the entire generator system shall be sufficient cause for Engineer / Owner complete rejection of the generator system supplier's submitted/furnished the generator system equipment. The CONTRACTOR and the generator system supplier shall be responsible for all project delays, costs, Engineer fees, and Owner revenue losses associated with any partial or complete rejection of the generator system supplier's submitted and/or furnished equipment.

END OF SECTION

SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. A Lightning Protection System shall be provided and installed for the Electrical Building No. 2. The system shall be provided and installed in compliance with provisions of Code for Lightning Protection Systems as adopted by the National Fire Protection Association and Lightning Protection Institute. All equipment to that result shall be included whether or not specifically called for herein. Installers shall be LPI (Lightning Protection Institute) certified, master and Journeyman in accordance with LPI standards or of equal qualifications as approved by Engineer. A LPI label for the system shall be required.
- B. Material shall comply in weight, size and composition with the requirements of the Lightning Protection Institute and the National Fire Protection Code relating to this type of installation, and shall be LPI labeled.
 - 1. All materials, where available by any one manufacturer, shall be cast. All bolts shall have hexagonal heads, no screw heads will be permitted.
 - 2. Lightning protection cable shall be Class I copper. Grounding counterpoise shall be as shown. Fittings and straps shall be cast copper.
- C. All buildings and the ground storage tank shall be provided with the lightning protection system.

1.02 SUBMITTALS

- A. Shop Drawings: Shop drawings shall be submitted before work is done. Drawings shall include full layout of cabling and points, and connections.
- B. Product Data: Product Data shall be submitted on all equipment to show compliance with this section of the specifications and shall include manufacturer's written recommendations for installation.

PART 2 - PRODUCTS

2.01 AIR TERMINALS

- A. Air terminals shall be copper as required to match roof conductors, and shall have proper base support for surface on which they are attached, and shall be securely anchored to this surface. Terminals shall project a minimum of 10" above top of object to which attached.

2.02 CONDUCTORS

- A. Roof conductors shall consist of copper complying with the weight and construction requirements of the Code, and shall be coursed to interconnect with air terminals, and in general, provide a two-way minimum path to ground. The angle of any turn shall not exceed 90 degrees, and shall provide an approximately horizontal or downward course. Down conductors shall be copper, concealed within the structure. Radius of bends shall not be less than 8 inches. Roof conductors material shall match and/or be compatible with roof flashing material.

2.03 FASTENER

- A. Conductor fasteners shall be of the same material as the conductor, having ample strength to support conductor. Where fasteners are to be mounted in masonry or structural work, they shall be furnished to the Masonry or Structural Contractor so they may be installed during construction of the project.

2.04 GROUND CONNECTIONS

- A. Ground connections shall be made in accordance with requirements of all applicable codes. Ground rods shall be placed in a minimum of two (2) feet from building foundations. In addition to above artificial grounds, one down conductor of each two-path system shall be connected to water piping system with approved water pipe type strap connector. All ground rods shall be 5/8" diameter, with a minimum length of 20' copperweld type. Each installed ground rod shall be checked for resistance to ground. If a 0 to 5 ohm reading is not obtained, extend 10' rod lengths and continue driving rods until the required reading is obtained. No rod can be connected to the bonding cable without the required ohm reading. The system must also be tied into the existing plant system.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be made in an inconspicuous manner with conductors coursed to conceal equipment as much as possible. Down conductors shall be concealed within structure, and shall be run in 1" PVC conduit. All metallic equipment within 6 feet of any lightning conductor shall be bonded to conductor. System shall also be tied to the main service electrical ground.

3.02 EQUIPMENT

- A. Equipment shall be as manufactured by Thompson Lightning Protection, Inc., National Lightning Protection, Inc., Lightning Masters Corp., or Heary Bros Lightning Protection (premium lines).

END OF SECTION

SECTION 26 50 00

LIGHTING SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install complete lighting systems including panelboards, transformers, lighting fixtures, receptacles, switches, contactors and all necessary accessories and appurtenances required as hereinafter specified and shown on the Drawings.

1.02 STANDARDS

- A. All lighting fixtures shall be in accordance with the National Electrical Code and shall be constructed in accordance with the latest edition of the Underwriters Laboratories "Standards for Safety, Electric Lighting Fixtures." All lighting fixtures shall be Underwriters Laboratories labeled.

1.03 RELATED WORK

- A. Panelboards shall be as specified under Section 26 24 10.
- B. Conduit shall be as specified under Section 40 95 15.
- C. Wire shall be as specified under Section 26 05 19.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Switches:
 - 1. Wall switches shall be of the indicating, toggle action, flush mounting quiet type. All switches shall conform to Federal Specification W-S-896-D.
 - 2. Wall switches shall be of the following types and manufacturer or approved equal.
 - a) Single pole - Arrow-Hart No. 1991 or Leviton No. 1221-2.
 - b) Double pole - Arrow-Hart No. 1992 or Leviton No. 1222-2.
 - c) Three way - Arrow -Hart No. 1993 or Leviton No. 1223-2.
 - d) Four way - Arrow-Hart No. 1994 or Leviton No. 1224-2.
 - e) Single pole, key operated - Arrow-Hart No. 1991-L or Leviton No. 1221-2L.

- f) Momentary contact, 2 circuit, center off - Arrow-Hart No. 1895 or Leviton No. 1256.
- g) Weatherproof cover for Arrow-Hart 2900 series tap action switches - Arrow-Hart Catalog No. 2881-G.

B. Receptacles:

1. Wall receptacles shall be of the following types and manufacturer or approved equal.
 - a) Single, 20A, 125V, 1P, 3W; Arrow-Hart No. 5361 or Leviton No. 5361.
 - b) Duplex, 20A, 125V, 2P, 3W; Arrow-Hart No. 5362 or Leviton No. 5362.
 - c) Corrosion-resistant, duplex, 20A, 125V, 2P, 3W; Arrow-Hart No. 5739-CR or Leviton No. 5362CR and Crouse-Hinds WLRD-1 cover.
 - d) 60A, 480V, 3P, 2W; weatherproof receptacle shall be Crouse-Hinds Catalog No. ARE6324 with Crouse-Hinds Catalog No. APJ 6385 plug.
 - e) Ground fault interrupter, duplex, 20A, 125V, 3P, 2W; Arrow-Hart No. GF5362 or Leviton No. 6899.
 - f) Stainless steel indoor mounting plate for G.F.I. receptacle; Arrow-Hart Catalog No. S-26.
 - g) Clock hanger, 15A, 125V, 2P, 3W; Arrow-Hart No. 452 or Leviton No. 628.
 - h) Single, 20A, 250V, 2P, 3W; Arrow-Hart No. 5461 or Leviton No. 5461.
 - i) Single, 30A, 125V, 2P, 3W; Arrow-Hart No. 5716N; cap: Arrow-Hart No. 5717N or Leviton No. 5371.
 - j) Clothes dryer, 30A, 125/250V, 3P, 3W; Arrow-Hart No. 9344N. Cap: Arrow-Hart No. 9352AN or Leviton No. 5209 and No. 9382-P.
2. Receptacles (Weatherproof/NEMA 4 Areas/Outside)
 - a) General Requirements: Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked "Suitable for Wet Locations While In Use" and "UL Listed". There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base to assure proper seal. Taymac; Specification Grade.

3. Special wiring devices shall be provided as noted of the drawings.
 - a) Tamper resistant duplex receptacle Leviton No. 5262-SG or approved equal.
 - b) Wall switch occupancy sensor Leviton No. 6775 or approve equal.
 - c) Scene select microprocessor dimmer Leviton No. 17765 or approved equal.
 - d) Surge protective duplex receptacle Leviton No. 5380 or approved equal.

C. Device Plates:

1. Plates for flush mounted devices shall be of the required number of gangs for the application involved and shall be 302 (18-8) high nickel stainless steel of the same manufacturer as the device.
2. Plates for surface mounted device boxes shall be of the same material as the box.

D. Lighting Fixtures:

1. Lighting fixture types shall be as shown on the "Lighting Fixture Schedule" on the Drawings. The catalog numbers listed are given as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers will be reviewed. Photometric and minimum in order for ENGINEER to consider equivalency.

E. Lamps:

1. All lighting fixtures shall be LED type.
2. All lamps shall be of one manufacturer and shall be as manufactured by Lithonia, Hubble Lighting, SESCO Lighting, Sylvania Electric Products, Inc., or General Electric Company, or approved equal.

F. Flexible Fixture Hangers:

1. Flexible fixture hangers used in nonhazardous areas shall be Type ARB and flexible fixture supports used in hazardous areas shall be Type ECHF as manufactured by the Crouse-Hinds Company or approved equal.
2. Steel channel, roll formed into U-shape, shall be used to span between building steel for mounting of fixtures where required by fixture location or as indicated on the Drawings. Channel shall be as manufactured by Unistrut Corporation or approved equal.

G. Lighting Contactor:

1. Lighting contactor shall be of the electrically operated, mechanically held type in NEMA 4X stainless steel enclosures of the number of poles as called for on the Drawings.
2. Contactors shall be rated for 20A-600 volt contacts and be similar and equal to Automatic Switch Company bulletin 1255-166 RC.

H. Photocell:

1. Intermatic K4400 series or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.
- B. When fixtures are noted to be installed flush, they shall be complete with the proper accessories for installing in the particular ceiling involved. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.
- C. Flexible fixture hangers shall be used for all pendant mounted fixtures.
- D. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.
- E. Receptacles in process areas and shops shall be mounted 36 inches above the floor unless otherwise noted on the Drawings.
- F. Receptacles in office and other like areas shall be mounted 18 inches above the floor unless otherwise noted on the Drawings.

3.02 SPARE LAMPS

- A. None required.

3.03 CLEANING UP

- A. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

END OF SECTION

SECTION 31 01 01

SITE RESTORATION

PART 1 --GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall make repairs to landscaped and grassed areas that may be damaged by Contractor activities as specified herein.

1.02 SUBMITTALS

- A. The Contractor shall submit submittals for review in accordance with Section 01300, Submittals.
- B. The Contractor shall apply to NAU for and secure a permit to perform excavations for this Contract. All excavation activity on site shall conform to the permit requirements.

1.03 DEFINITIONS

- A. The phrase "DOT Specifications" shall refer to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction. The DOT Specifications are referred to herein and are hereby made a part of this Contract to the extent of such references, and shall be as binding upon the Contract as though reproduced herein in their entirety.

1.04 PROTECTION OF EXISTING IMPROVEMENTS

- A. The Contractor shall be responsible for the protection of all pavements and other improvements within the work area. All damage to such improvements, as a result of the Contractor's operations, beyond the limits of the work of pavement replacement shall be repaired by the Contractor at his expense.

1.05 GUARANTEE

- A. The Contractor shall guarantee all trees, ground cover, or shrubs planted or replanted under this Contract for a period of one (1) year beyond acceptance of the project. In the event that any new tree, plant, or shrub dies within the guarantee period, the Contractor shall be responsible for replacement in kind. In the event that a transplanted (reused) tree dies within the guarantee period, the Contractor shall be responsible for replacement in kind, except that the maximum height of any new tree shall be eight (8) feet as measured from the ground surface, once planted, to the top of the tree.

PART 2 --PRODUCTS

2.01 SOD

- A. Sod shall be replaced when removed or damaged during construction. Sod shall be FDOT Bermuda type.

2.02 REPLACEMENT TREES, GROUND COVER AND SHRUBS

- A. Replacement trees, ground cover, and shrubs shall be of the same type, size and sound and shall be healthy, vigorous, well-branched, and densely foliated when in leaf. They shall have healthy, well-developed root systems and shall be free of disease and insect pests, eggs, or larvae.

2.03 MULCH

- A. Mulch shall be windproof shredded eucalyptus. Mulch shall be clean, fresh, free of branches and other foreign matter. Mulch shall be used around all shrubs, ground covers, and tree trunks, and placed to a minimum depth of 2 inches extending from the tree trunk outward two (2) feet.

PART 3 --EXECUTION

3.01 GRADING AND SODDING

- A. The Contractor shall regrade the work areas disturbed by his construction activities to the existing grade prior to commencement of construction.
- B. Sod shall be placed on all grassed areas disturbed by construction activities, unless otherwise indicated on the Drawings.
- C. Maintenance: Sufficient watering shall be done by the Contractor to maintain adequate moisture for optimum development of the sodded areas. Sodded areas shall receive no less than 1.5 inches of water per week.
- D. Repairs to Lawn Areas Disturbed by Contractor's Operations: Lawn areas damaged by CONTRACTOR's operations shall be repaired at once by proper sod bed preparation, fertilization and resodding, in accordance with these specifications. Regardless of the condition of the lawn area (weed content etc.) prior to the Contractor working in the area, all repairs shall be made with sod.

3.02 TREES, GROUND COVER AND SHRUBS

- A. Excavation and Plant Holes: Plant hole excavations shall be roughly cylindrical in shape, with the side approximately vertical. Plants shall be centered in the hole. Bottoms of the holes shall be loosened at least six (6) inches deeper than the required depth of excavation.

- B. Holes for balled and burlapped plants shall be large enough to allow at least eight inches of backfill around the earth ball. For root balls over 18 inches in diameter, this dimension shall be increased to 12 inches. Where excess material has been excavated from the plant hole, the excavated material shall be disposed of as and where directed by NAU.
- C. Setting of Plants: When lowered into the hole, the plant shall rest on a prepared hole bottom such that the roots are level with, or slightly above, the level of their previous growth and so oriented such as to present the best appearance. The Contractor, when setting plants in holes, shall make allowances for any anticipated setting of plants.
- D. Palms of the sabal species may be set deeper than the depth of their original growth, provided that the specified clear trunk height is attained.
- E. The backfill shall be made with planting mixture and shall be firmly rodded and watered-in, so that no air pockets remain. The quantity of water applied immediately upon planting shall be sufficient to thoroughly moisten all of the backfilled earth. Plants shall be kept in a moistened condition for the duration of the Contract.
- F. Staking and Guying: Plants shall be staked in accordance with the following provisions:
- 1 Small Trees: For trees and shrubs of less than one-inch caliper, the size of stakes and the method of tying shall be such as to rigidly support the staked plant against damage caused by wind action or other effects. Trees larger than one inch and smaller than one and one-half inch caliper shall be staked with a two-inch stake, set at least 24 inches in the ground and extending to the crown of the plant. The plant shall be firmly fastened to the stake with two strands of 14-gauge soft wire, enclosed in rubber hose, or other approved covering. The wire shall then be nailed or stapled to the stake to prevent slippage.
 - 2 Medium Trees: All trees, other than palm trees, larger than one and one-half inch caliper and smaller than two and one-half inch caliper shall be staked with two or more, two-inch by two-inch stakes, eight feet long, set two feet in the ground. The tree shall be midway between the stakes and held firmly in place by two strands of 12-gauge wire, applied as specified above for single stakes. The wires shall be tightened and kept tight by twisting.
 - 3 Large Trees: All trees, other than palm trees, larger than two and one-half inch caliper, shall be braced with three or more two-inch by four-inch wood braces, toenailed to cleats which are securely banded at two points to the tree, at a point at least six feet above the ground. The trunk shall be padded with five layers of burlap under the cleats. Braces shall be approximately equidistantly spaced and secured underground with

two-inch by four-inch by 24-inch stake pads. In firm rock soils, Number 4 steel reinforcing rods or one-half inch pipe is acceptable.

- 4 Palm Trees: Palm trees shall be braced with three or more two-inch by four-inch wood braces, toenailed to cleats which are securely banded at two points to the palm, at a point at least six feet above the ground. The trunk shall be padded with five layers of burlap under the cleats. Braces shall be approximately equidistantly spaced and secured underground with two-inch by four-inch by 24-inch stake pads. In firm rock soils, Number 4 steel reinforcing rods or one-half inch pipe is acceptable.

- G. Pruning: All broken or damaged roots shall be cut off smoothly, and the tops of all trees shall be pruned in a manner complying with standard horticultural practice. At the time pruning is completed, all remaining wood shall be alive. All cut surfaces of one (1) inch or more in diameter, above the ground, shall be treated with an approved commercial tree paint.
- H. Maintenance: Maintenance shall begin immediately after each plant is planted and shall continue until all work under this Contract has been completed and accepted by NAU. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated, and otherwise maintained and protected. Settled plants shall be reset to proper grade position, planting saucer restored, and dead material removed. Guys shall be tightened and repaired.
- I. Defective work shall be corrected as soon as possible after it becomes apparent. Upon completion of planting, the Contractor shall remove excess soil and debris and repair any damage to structures, etc., resulting from planting operations.

END OF SECTION

SECTION 31 01 10

SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 DESCRIPTION OF WORK:

- A. Extent of site clearing is shown on drawings.
- B. Site clearing work includes, but is not limited to:
 - 1. Protection of existing trees.
 - 2. Removal of trees and other vegetation.
 - 3. Topsoil stripping.
 - 4. Clearing and grubbing.
 - 5. Removing above-grade improvements.
 - 6. Removing below-grade improvements.

1.03 JOB CONDITIONS:

A. Traffic

Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction.

B. Protection of Existing Improvements

Provide protections necessary to prevent damage to existing improvements indicated to remain in place.

- 1. Protect improvements on adjoining properties and on Owner's property.

2. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

C. Protection of Existing Trees and Vegetation

Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark.

1. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to Architect/Engineer. Employ licensed arborist to repair damages to trees and shrubs.
2. Replace trees which cannot be repaired and restored to full-growth status, as determined by arborist.

D. Salvable Improvements

Carefully remove items indicated to be salvaged, and store on Owner's premises where indicated or directed.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SITE CLEARING:

A. General

All site vegetation (i.e. trees and underbrush) within the planned construction areas shall be cleared, including their root systems and the surficial silty/organic topsoils. This clearing/stripping work shall be performed within and to a distance of at least five feet beyond the perimeter of the planned construction areas. The perimeter areas may then need to be graded to help direct surface water runoff away from the planned construction areas.

B. Topsoil

Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.

1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.

2. Remove heavy growths of grass from areas before stripping.
3. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to the main root system.
4. Stockpile topsoil in storage piles in areas shown, or where directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust. Dispose of unsuitable or excess topsoil same as waste material, herein specified.

C. Clearing and Grubbing

Clear site of trees, shrubs and other vegetation, except for those indicated to be left standing.

1. Completely remove all surface vegetation, debris and other deleterious materials including root systems and the surficial silty/organic topsoils.
2. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated to be left standing.
4. Clearing/stripping work shall be performed within a distance of at least 5 feet beyond the perimeter of the construction area.

D. Removal of Improvements

Remove existing above-grade and below-grade improvements necessary to permit construction, and other work as indicated.

3.02 DISPOSAL OF WASTE MATERIALS:

A. Burning on Owner's Property

Burning is not permitted on Owner's property.

B. Removal from Owner's Property

Remove waste materials and unsuitable and excess topsoil from Owner's property and dispose of off site in legal manner.

END OF SECTION

SECTION 31 22 19

EARTHWORK AND SITE GRADING

PART 1 - GENERAL

1.01 SCOPE:

- A. The work under this section includes the furnishing of all labor, materials, tools and equipment necessary to complete the earthwork shown on the drawings and specified herein including clearing and grubbing, stripping topsoil and grading.

1.02 GENERAL REQUIREMENTS:

- A. The Owner has made borings at the site. Such boring data, including groundwater elevations or conditions are available from the Engineer's office or included in the specifications. They are presented only as information that is available which indicates certain conditions found and limited to the exact locations and on the dates indicated. The inclusion of such data shall not be interpreted as an indication of conditions that may actually be developed through the period of construction.
- B. Earthwork shall be in accordance with the recommendations of the Geotechnical Report for the project and as specified herein.
- C. All suitable material resulting from excavation shall be used where needed on the job site.
- D. In the event that excavated material does not meet the full requirements of the job in either quality or quantity, the Contractor shall be required to furnish any necessary fill.
- E. Contractor shall examine the site of the work and make his own determination of the character of materials and the conditions to be encountered on the work, and his proposal shall be based upon his own investigations. Neither the Owner nor his representatives shall be held responsible for variations found to exist between the data above referred to and actual field conditions that develop through the period of construction.
- F. Underground structures and utilities shown on the drawings are located according to the best available records. However, it shall be the Contractor's responsibility to acquaint himself with all information and to locate all underground structures and utilities along the line of work in order to avoid conflict with existing facilities. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions.

Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner. Neither the Owner nor the Engineer shall be held accountable for inaccuracies or omissions in the location or grade of facilities of this type.

- G. Where actual conflicts are unavoidable, work shall be performed so as to cause as little interference as possible with the service rendered by the facility disturbed. Facilities or structure damaged in the prosecution of the work shall be repaired immediately at the Contractor's expense, in conformance with the best standard practice, to the satisfaction of the facility owner and to the extent required including replacement.
- H. Benchmarks and other reference points shall be carefully maintained and, if disturbed or destroyed, shall be replaced to the satisfaction of the Engineer and at no additional cost to the Owner. Location of benchmarks and other reference points not shown on the drawings but used during construction shall be recorded on the Contractor's "As-Builts" of the Contract Drawings.
- I. The use of explosives is not permitted.

1.03 PROTECTION OF EXISTING PROPERTY:

- A. The Contractor shall inform himself concerning the location of existing pipelines, utilities, and structures of every type below, on or above ground which may interfere with his operations. He shall enter into the contract in full responsibility of the conditions that may be encountered and his responsibility in connection therewith. Upon award of the Contract, the Contractor shall inform the Owners of any such utilities and structures that his plan or operations may affect, in sufficient time to arrange for the work of removing, relocating or reconstructing, as may be necessary. The Contractor shall pay for the relocation of any existing overhead or underground utilities, unless otherwise shown on the drawings or authorized by the Engineer.
- B. All existing pipes, poles, wires, fences, curbing, property lines, markers and other structures, which must be preserved in place without being temporarily or permanently relocated, shall be carefully supported and protected from damage by the Contractor. Should such items be damaged, they shall be restored at the expense of the Contractor to at least as good condition as that in which they were found immediately before the work was begun.
- C. On paved surfaces, the Contractor shall attempt to avoid the use of tractors, bulldozers or other power-operated equipment which would damage such surfaces. All surfaces which have been damaged by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun. Suitable materials and methods shall be used for such restoration.

- D. No charge or claim for additional compensation shall be made by the Contractor for any delay or hindrance regardless of duration, caused by the failure of the owners of structures on, under, or over the project to adjust their facilities during the progress of any portion of the contract work.

1.04 PROTECTION OF EXISTING TREES AND SHRUBS:

Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark.

- A. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to Architect/Engineer. Employ licensed arborist to repair damages to trees and shrubs.
- B. Replace trees which cannot be repaired and restored to full-growth status, as determined by arborist.
- C. The Contractor shall inform the plant operator of the areas that will be required for construction prior to commencing operations so that the affected shrubs, plant, etc., may be removed if so desired; otherwise, said plants and shrubs shall be removed by the Contractor and replaced or replanted in kind by the Contractor upon completion of construction at no additional cost.
- D. The Contractor will be required to replant or replace in kind any sod, shrubs, plants, etc., removed during construction. He will be required to block out sod in neat squares provided it is to be replanted within 48 hours, wrap root area of plants, shrubs, etc. with burlap bags, wet down, and keep in good condition for replanting. The Contractor will also be required to replace the topsoil within the limit of the construction in non-pavement areas.

PART 2 – PRODUCTS

2.01 UNSUITABLE MATERIALS:

- A. Material classified as A-5, A-6, or A-7 as set forth by the latest AASHTO Soil Classification Standards shall be deemed unsuitable. All other material shall have a maximum plasticity index of 10 and a maximum liquid limit of 40.

2.02 SUITABLE MATERIAL

- A. Suitable backfill and fill material shall be as defined in the Geotechnical Report for the project.

PART 3 - EXECUTION

3.01 CLEARING AND GRUBBING:

- A. Clearing and grubbing shall be performed in the areas as required and where required to provide adequate work space including space for control stakes and hubs for pipeline work; and including ditches, areas where fill will be placed, and where structures will be erected. Trees and permanent structures in construction areas shall be removed as shown on the drawings or as directed. Removal of valuable trees or shrubs, if required, shall be done in cooperation with the Owner in order that they may be replanted, if so desired, by the Owner. In areas where working room is restricted, the Contractor shall protect privately owned trees and shrubs bordering the construction areas from damage and take full responsibility for such damages.
- B. All trees, brush, logs, snags, leaves, sawdust, bark, weeds, rubbish and all other obstructions resting on or protruding through the surface of the existing ground shall be collected and satisfactorily disposed of in compliance with all applicable laws and regulations. All such material shall be removed to a depth of one foot below natural grade. All stumps including the major root systems shall be removed, and the area grubbed as specified herein.
- C. Where excavation is done within the areas to be cleared and grubbed, all stumps and roots over one-half (1/2) inches in diameter and deleterious material thereby exposed shall be removed to a depth of one (1) foot below the excavated surface.
- D. Where stumps are removed from areas other than those where subsequent excavation, filling and grading will be done, no depressions shall be left, but the resulting holes shall be filled and neatly graded to conform to the grades indicated on the drawings.
- E. All material removed during clearing and grubbing shall be disposed of at a suitable City, County or private dump, and in accordance with all applicable laws and regulations. All dumping charges are to be paid by the Contractor.
- F. The use of herbicides or blasting in clearing and grubbing is specifically prohibited.

3.02 BACKFILL AND FILL

- A. Place specified soil material in layers to required subgrade elevations:
 - 1. In excavations, use satisfactory excavated or borrow material.
 - 2. Under grassed areas, use satisfactory excavated or borrow material.

3. Under walks and pavements, use subbase material, or satisfactory

3.02 STRIPPING TOPSOIL:

- A. Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.
- B. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
- C. Remove heavy growth of grass from areas before stripping.
- D. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.
- E. Stockpile topsoil in areas shown, or where directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust. Dispose of unsuitable or excess topsoil same as waste material.

3.03 REMOVAL OF IMPROVEMENTS

- A. Remove existing above-grade and below-grade improvements necessary to permit construction, and other work as indicated.

3.04 DUST CONTROL:

- A. If, in the opinion of the Owner, it is necessary to control dust from time to time during the progress of the work, the Contractor shall furnish and spread calcium chloride at the site of the work as directed at no additional cost to the Owner.

3.05 EXCESS MATERIAL:

- A. Remove waste materials and unsuitable and excess topsoil from Owner's property and dispose of off-site in legal manner.
- B. Burning is not permitted on Owner's property.
- C. Place excess topsoil and suitable excavated material in berm as indicated on the drawings.

3.06 GRADING:

- A. Grade all areas as indicated. Fill shall be brought to finish grades shown and shall be graded to drain water away from structures.
- B. Within the limits of construction and outer limits of clearing and grubbing, all

holes and other depressions shall be filled, all mounds and ridges cut down, and the area brought to sufficiently uniform contour that the Owner's subsequent mowing operations will not be hindered by irregular terrain. This work shall be done regardless of whether the irregularities were the result of the Contractor's operations or originally existed.

3.07 SILTATION AND EROSION:

- A. The Contractor shall take steps and make provisions to minimize siltation and erosion which may result from, or as a result of, his operations during the course of construction of this project.

END OF SECTION

SECTION 31 23 16

STRUCTURAL EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Work specified herein and elsewhere:
 - 1. Work under this Section includes:
 - a. Excavation and backfill for structures.
 - b. Structural fill.
 - c. Granular bedding and fill under concrete slabs.
 - d. Disposal of excess excavated material.

1.02 CLASSIFICATION:

- A. Excavation will be unclassified regardless of the nature of the materials encountered.

1.03 SUBMITTALS:

- A. Submit product data and an 8 inch by 10 inch sample of proposed filter fabric. If requested by the Engineer, furnish certification that filter fabric meets specified chemical and physical requirements.

1.04 DELIVERY AND STORAGE:

- A. During shipment and storage, protect plastic filter fabric from direct sunlight, ultraviolet rays and temperatures over 140 degrees F.

PART 2 - PRODUCTS

2.01 STRUCTURAL FILL:

- A. Structural fill shall be a coarse aggregate complying with the following gradation:

<u>U.S. Standard Sieve Size</u>	<u>Percent Passing By Weight</u>

1-1/2 Inch	100
1 Inch	90 - 100
1/2 Inch	60 - 90
No. 4	35 - 55
No. 16	10 - 40
No. 200	4 - 12

2.02 GRANULAR FILL:

- A. Granular fill shall consist primarily of sand and gravel, free from vegetation or other deleterious material. Any coarse aggregate contained in the material shall pass the 1-1/2 inch sieve. Not more than 15% of fines shall pass the No. 200 sieve.

2.03 BACKFILL:

- A. Backfill may be previously excavated materials free from cinders, construction debris, vegetation, or other extraneous material and suitable for the intended purpose and compaction requirements.

2.04 GRANULAR DRAINAGE BLANKET:

- A. Granular drainage blanket material shall be coarse aggregate complying with the following gradation:

<u>U.S. Standard Sieve Size</u>	<u>Percent Passing by Weight</u>
3 Inch	100
1 Inch	90 - 100
No. 4	50 - 100
No. 16	30 - 80
No. 50	0 - 20
No. 200	0 - 4

2.05 PLASTIC FILTER FABRIC:

- A. Plastic filter fabric shall be woven or non-woven fabric consisting of monofilament strands of nylon, polypropylene, vinylidene, chloride, or other approved material. Plastic filter fabric shall be free of defects or flaws which significantly affect its physical properties. Filter fabric shall have the following properties:

Equivalent Opening Size (EOS)	Max. .004 in. Min. .001 in.

Weight (ASTM D1910)	Min. 4.0 oz./sq. yd.
Absorption (Water)	Max. 1% by weight
Grab Strength, Wet (ASTM D1682)	Min. 80 lbs./in.
Elongation (ASTM D1682)	Min. 10%

2.06 GRANULAR FILTER:

- A. Granular filter material shall be coarse aggregate complying with the following gradation:

<u>U.S. Standard Sieve Size</u>	<u>Percent Passing by Weight</u>
3/4 Inch	100
1/2 Inch	94 - 100
3/8 Inch	75 - 95
No. 4	20 - 50
No. 16	0 - 6

PART 3 - EXECUTION

3.01 STRUCTURAL EXCAVATION:

- A. Excavate to the depth and dimensions necessary for the construction; maintain excavations in good order; and provide barricades and warning lights as required. If underground utilities and/or structures not shown on the Drawings are encountered, notify the Engineer and do not proceed until instructions are obtained. Notify the Engineer if running water is encountered.
- B. The bottom of all excavations shall be undisturbed earth unless otherwise noted, and shall be approved before subsequent work is started.
- C. If the bottom of excavations consists of material unstable to such a degree that, in the opinion of the Engineer, it cannot adequately support the structure, overexcavate and backfill with well-compacted granular fill or lean (2500 psi) concrete. Where excavation and backfill below the Limits of Excavation defined on the Drawings is ordered in writing by the Engineer, such additional excavation and backfill will be paid for as Extra Work. Where the Limit of Excavation is not defined, the Limit shall be taken as the base of the footing.
- D. Dewatering: The contractor is solely responsible for the design, installation, operation and subsequent removal of dewatering systems and their safety and conformity with local codes and regulations. The system shall be subject to approval by the Engineer. Prevent surface and subsurface water and ground water from flowing into excavations. At all times maintain excavations free from any accumulation of water. Provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components

necessary to convey water away from excavations. Locate sumps outside of load bearing areas. Maintain groundwater elevation at least 2 feet below the excavation subgrade during fill, backfill and compaction work. Allow groundwater table to rise gradually as the fill/backfill work proceeds. The method of disposing of water pumped from the excavation shall be approved by the Engineer prior to actual disposal.

- E. Do not excavate for any structure until that structure is scheduled for construction. If the bearing capacity of the foundation soils is reduced because the excavation is allowed to remain open prior to commencing work, the weathered soil shall be removed and replaced with lean (2500 psi) concrete or compacted granular fill at the expense of the Contractor.
- F. Excavations carried below depths indicated on the Drawings without the previous approval of the Engineer shall be filled with lean (2500 psi) concrete or compacted granular fill to the correct elevation at the expense of the Contractor.
- G. Side forms on footings will not be required if the soil is stable and square corners and straight sides are maintained until concrete is placed; otherwise, excavate outside the foundation lines to allow for installation and removal of formwork and for inspection.

3.02 FILLING, BEDDING, AND BACKFILLING:

A. General:

- 1. Obtain the Engineer's approval of existing conditions before starting filling operations. Remove all vegetation, formwork, rubbish, and other debris. Excavate muddy subgrade.
- 2. Place backfill material in 4 inch loose depth layers and compact with hand tampers or by hand-operated mechanical tampers.
- 3. Compact top 12 in. of subgrade and each layer of backfill material to not less than 95 percent maximum dry density for cohesive material determined in accordance with ASTM D 1557; and 95 percent relative density for cohesionless material determined in accordance with ASTM D 2049.

B. Structural Fill:

1. Provide structural fill under all water containing structures and tanks or where otherwise indicated on the drawings to achieve necessary lines and grades under foundations.
- C. Granular Fill:
1. Provide granular fill where indicated on the Drawings to achieve necessary grades under non water containing structure concrete slabs and elsewhere, as indicated.
- D. Granular Drainage Blanket:
1. Provide granular drainage blanket as indicated on the Drawings under slabs and against walls to provide for the free movement of water to the weep holes.
- E. Filter Fabric:
1. Provide filter fabric as indicated on the Drawings.
- F. Granular Filter:
1. Provide a cubical deposit of material as indicated on the drawings.
- G. Backfilling:
1. Do not backfill until new concrete has properly cured and any required tests have been accepted.
 2. Exercise care during backfilling operations.
 3. Where backfilling is required on both sides of structures, backfill and compact simultaneously on opposite sides in even layers. Other backfilling sequences shall be as specifically indicated.

3.03 DISPOSAL OF EXCAVATED MATERIAL:

- A. Excess excavated material not suitable or required for backfilling or site grading, and all materials containing slag, cinders, foundry slag, debris, and rubble shall be removed from the site and legally disposed.

3.04 COMPACTION CONTROL AND TESTING:

- A. Employ, at Contractor's expense, a testing laboratory to perform soil testing and inspection service for quality control testing.
- B. Testing service to inspect and approve subgrades and fill layers before further construction work is performed.
- C. Perform field density tests in accordance with ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method) or ASTM 2922 and ASTM 3017 (Nuclear Testing Method) as applicable.
 - 1. Footing Subgrade: For each subgrade conduct one test to verify required design bearing capacities.
 - a. Water Containing Structure and Building Slab Subgrade: One field density test of subgrade for each 2,000 sq. ft. of overlaying concrete covered area, minimum 3 tests. One field density test for each layer of compacted fill, for each 2,000 sq. ft. of overlaying concrete covered area, minimum 3 tests each layer.
 - b. Foundation Wall Backfill: 2 field density tests, at locations and elevations as directed.
- D. If in the opinion of the Engineer, based on the testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing until satisfactory results are obtained.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK:

1. Provide all labor, materials, necessary equipment and services to complete the dewatering Work, as indicated on the Drawings, as specified herein or both.

1.03 RELATED WORK:

- A. Section 31 22 19 - Earthwork and Site Grading
- B. Section 31 23 16 - Structural Excavation and Backfill

PART 2 – PRODUCTS

2.01 EQUIPMENT

- A. Dewatering, where required, may include the use of temporary reservoirs and diking, well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment must be maintained on the job site and operate within any local noise ordinance limits. All safety requirements, fencing, etc. shall be installed and maintained by the Contractor.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS:

- A. The Contractor shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.
- B. Dewatering for structures and pipelines shall commence when groundwater is

first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

- C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations, Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.
- D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with pea rock at no additional cost to the Owner.
- F. The Contractor shall maintain the water level below the bottom of excavation in all Work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.
- G. The Contractor shall prevent flotation by maintaining a positive and continuous removal of water. The contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.
- H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sand-packed and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the Contractor shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.
- I. The Contractor shall dispose of water from the Work in a suitable manner without damage to adjacent property. Contractor shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into Work built or under construction without prior consent of the Engineer. Water shall be filtered using a silt box or another approved method to remove sand and fine-sized soil particles before disposal into any drainage system. The Engineer prior to being used shall approve dewatering disposal points. Storm drains used by the Contractor for dewatering shall be cleaned by a jet vac, or other method approved by the Engineer after dewatering is complete.
- J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of

structures, pipelines, and sewers.

- K. Dewatering of trenches and other excavations shall be considered, as incidental to the construction of the Work and all costs thereof shall be included in the various Contract prices in the Bid Forms, unless a separate Bid item has been established for dewatering.
- L. The Contractor shall submit a dewatering plan to the Engineer for review. The Contractor is advised that the FDEP and/or SJWMD may require that a dewatering plan, prepared by a State of Florida licensed Professional Engineer or Registered Professional Geologist, be submitted and approved prior to issuance of a dewatering permit.
- M. The Contractor is advised that the FDEP may have identified contaminated sites within 1/4-mile radius of the Project site. The Contractor may be required to provide testing and monitoring of the dewatering operations, and to institute dewatering methods and controls, as required by FDEP.

3.02 QUALITY CONTROL:

- A. It shall be the sole responsibility of the Contractor to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.
- B. All dewatering operations shall be adequate to assure the integrity of the finished Project and shall be the responsibility of the Contractor.
- C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement, which may develop. The responsibility for conducting the dewatering operation in a manner, which will protect adjacent structures and facilities, rests solely with the Contractor. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

3.03 CONTRACTOR SUBMITTALS:

- A. Prior to commencement of excavation, the Contractor shall submit a detailed plan and operation schedule for dewatering of excavations. The Contractor may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The Contractor's dewatering plan is subject to review by the Engineer and regulatory agencies.

3.04 Measurement and Payment

- A. There shall be no special measurement or payment for the Work under this Section. It shall be included in the appropriate lump sum price Bid.

END OF SECTION

SECTION 31 23 23

SOIL COMPACTION CONTROL

PART 1 - GENERAL

1.01 GENERAL:

A. Section Summary

1. This section applies to control of soil compaction.
2. All work this section shall be performed in accordance with the requirements of the Owner's Geotechnical Engineer.

1.02 RELATED DOCUMENTS:

- ###### **A.**
- Drawings and general provisions of Contract, including General, Special and Supplementary Conditions and Divisions 00 and 01 Specification Sections, apply to this section.

1.03 COMPACTION REQUIREMENTS:

- ###### **A.**
- The percent compaction of maximum dry density as specified under Section 1.03, and required for fill and embankment areas within the scope of the project, unless otherwise defined in other Sections, are as follows:
1. General Fill Areas not located under roads, buildings, or other structures, 90% compaction, with reference to Standard Proctor.
 2. Fill Sections required for construction of roads and drives, 95% compaction, with reference to Standard Proctor.
 3. Backfill for underground utilities not falling under roads, or structures, including electrical conduit and duct banks, sewers, and general piping, 90% compaction, with reference to Standard Proctor.
 4. Backfill for underground utilities, as listed above, but falling under roads, drives or structures, 95% compaction, with reference to Standard Proctor.
 5. Fill materials supporting roadways, parking areas, sidewalks, structures, and buildings and backfill around structures shall be compacted to 95 percent of the maximum dry density in accordance with ASTM D 698. The top 12-inches of fill materials supporting structures or pavement shall be compacted to 98 percent of the maximum dry density. The moisture

content of the fill shall be as required in order to attain the degree of compaction specified. The fill materials shall be placed in layers which, before compaction, shall not exceed 8 in., unless otherwise specified. Each layer shall be spread uniformly and evenly and shall be thoroughly blade mixed during the spreading to insure uniformity of material in each layer.

6. The filling operation shall be continued as specified above until the fill has been brought to the slopes and grades as shown on the contract drawings, making proper allowances for thickness of topsoil, payment, floor slab, etc.
7. The fill shall be constructed in such a manner that the surface will be sloped to drain at all times and all fill shall be deposited to prevent excessive moisture accumulation from rain water. When the work is interrupted by rain, fill operations shall not be resumed until field tests indicate that the moisture content and density of the top 6 in. of fill is within the limits hereinbefore specified.
8. Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 5.0 horizontal to 1.0 vertical, the bank shall be stepped or benched, when considered necessary by the Engineer, in order that the placement of the fill be accomplished in horizontal layers.

1.04 COMPACTION RESULTS:

- A. The soils technician is to advise the Engineer immediately of any compaction tests failing to meet the specified minimum requirements. The Engineer will inform the soils technician of any retesting required. Formal reports of all test results will be submitted.
- B. The soils technician is also to advise the Contractor's superintendent immediately of any compaction tests failing to meet the specified minimum requirements. No additional lift is to be placed on a lift with any portion failing test unless authorized by the Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 31 30 00

EARTHWORK FOR UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. The work includes excavating, trenching, backfilling, compacting, grading and testing for the construction and installation of pipelines and related utilities for electric, telephone, fire, potable water and sewer services.
- B. Excavation will be open-cut unless otherwise shown on the drawings.
- C. Include clearing and grubbing, construction of cribbing and cofferdams, dewatering and incidental work.
- D. Whenever any piping, cable, telephone lines or other utility is encountered in excavation or other work, the Contractor shall notify the Owner, Engineer and applicable utility company immediately.

1.02 JOB CONDITIONS:

- A. Obtain all required approvals, permits and licenses before installing pipelines under existing roads and follow the rules and requirements of the authority having jurisdiction,
- B. If unauthorized overexcavation occurs, repair the area by backfilling with approved select material and compacting to required density.

1.03 EXCAVATION CLASSIFICATION:

- A. Regardless of the nature of material excavated, all excavation will be considered unclassified.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Backfill material shall be approved before use and shall be free of roots, brush, debris and other objectionable material.
- B. Excavated Materials: Use only approved material for backfill and provide additional material from approved sources. Excess excavated material for backfill may be transported and used in areas of deficiency.

2.02 SELECT BACKFILL:

- A. Utility Lines: Use suitable material in which all material passes a 3/8 inch sieve with not more than 10 percent passing a No. 200 sieve. Excavated material which meets this grading requirement may be used for select backfill.

PART 3 - EXECUTION

3.01 TRENCH EXCAVATION:

- A. General: Excavate trenches to lines, grades and elevations indicated or staked in the field. Fine grade the trench bottom throughout and excavate to accommodate joints and connections so the barrel of the pipe will receive bearing pressure throughout the trench bottom.
- B. Trenching Guidelines: For excavation, trench width and depth shall be as follows: ample width to allow a minimum free working space; width of hand excavated trenches may be reduced providing approval is given, stability of soil is consistent with depth of trench required and pipe can be satisfactorily installed to line and grade and properly backfilled. Hand excavate placements for thrust blocks, grade and trim sides straight upward to original ground; pump off water which has accumulated in low ground and keep excavation drained of water.
- C. If water is allowed to stand and the earth is softened, the earth shall be completely dried or replaced with firm material and the proper back-fill placed before construction can proceed.

3.02 SHORING AND SHEETING:

- A. Construct and maintain all shoring and sheeting necessary to protect the excavation and as required by applicable State and Federal laws.
- B. Do not disturb or remove timber or other sheeting driven to a depth below the elevation of the top of the pipe.
- C. Remove all other sheeting and shoring when safe to do so. Any portion wholly buried by earth and at least 18 inches from any timber members of permanent structures need not be stripped.

3.03 BACKFILL:

- A. General: Where placed in the road shoulder, the top 12 inches of back-fill shall be limerock, clay or suitable material mixture compacted to 95 percent density. Prior to final inspection and acceptance, level areas of fill to surrounding ground

surface. Do not backfill until all piping has been inspected, tested and approved for backfilling.

B. Trench Backfill:

1. Backfill trenches immediately after approval of the line construction.
2. Utility Line Backfill: Where lines are placed in the road shoulder, the top 12 inches of the backfill shall be limerock, clay or suitable material mixture compacted to 95 percent density. Use select backfill carefully placed in uniform layers not exceeding 6 inches in thickness to a depth of 1 foot over the top of the pipe. Place material and fill the area under the pipe haunches. Place each layer, moisten, then uniformly compact by use of hand, pneumatic, or mechanical tampers exercising care to prevent lateral displacement. Areas of backfill 1 foot to 4 feet over top of pipe or 1 foot over top of pipe to top of trench, whichever is less, shall be backfilled with a select material containing rocks no larger than 8 inches in the greatest dimension and shall be free of material with an exceptionally high void content. Backfill for more than 4 feet over top of pipe, as approved, meeting above requirements, except size of rocks, will not be limited. Moisten backfill above 1 foot over the top of the pipe and place in 8-inch layers. Puddling or flooding of trench for consolidation of backfill or use of wheel rolling by construction equipment shall not be done. Compact each layer with hand, pneumatic, or mechanical compactor.
3. Electric Conduit Trench: The same requirements shall apply for electric conduit as specified above except that select backfill is only required 4 inches above the top of the cable. Sharp rocks which could cut the conduit coating shall not be used.

3.04 CLEANUP:

- A. Finish grade all disturbed areas with no abrupt changes in grade or irregularities that will hold water. Prior to final inspection and acceptance, remove all rubbish and excess material and leave area in a neat, satisfactory condition.

END OF SECTION

SECTION 33 05 00

GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. All equipment furnished and installed under this contract shall conform to the general stipulations set forth in this section except as otherwise specified in other Sections.
2. Contractor shall coordinate all details of equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alternations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Project Specifications.

1.02 QUALITY ASSURANCE

A. **Materials and Equipment:** Unless otherwise specified, all materials and equipment furnished for permanent installation in the Work shall conform to applicable standards and specifications and shall be new, unused, of first quality manufactured in the United States, and undamaged when installed or otherwise incorporated in the Work. All materials shall conform to the appropriate AWWA standards. No such material or equipment shall be used by the Contractor for any purpose other than that intended or specified, unless such use is specifically authorized in writing by the City. No material shall be delivered to the work site workout prior acceptance of shop drawings and data by the Engineer.

B. Equivalent Materials and Equipment:

1. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function, and quality desired. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer to determine that the products proposed are equivalent to those named. Such items shall be submitted for review in accordance with Section 01340.
2. Requests for review of equivalency will not be accepted from anyone except the Contractor and such requests will not be considered until after the contract has been awarded.

- C. Governing Standards: Equipment and appurtenances shall be designed in conformity with ANSI, ASME, ASTM, IEEE, NEMA, OSHA, AGMA, and other generally accepted applicable standards. They shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation, and all conditions or operations. All bearings and moving parts shall be adequately protected against wear by bushings or other acceptable means. Provisions shall be made for adequate lubrication with readily accessible means.
- D. Tolerances: Machinery parts shall conform to the dimensions indicated on the Contract Drawings within allowable tolerances. Protruding members such as joints, corners, and gear covers shall be finished in appearance. All exposed welds shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.
- E. Clearances: Ample clearances shall be provided for inspection and adjustment. All equipment shall fit the allotted space and shall leave reasonable access room for servicing and repairs. Greater space and room required by substituted equipment shall be provided by the Contractor and at his expense.
- F. Testing:
1. When the equipment is specified to be factory tested, the results of the tests shall be submitted to the Engineer and approval of the test results shall be obtained before shipment of the equipment.
 2. When an item of equipment, including controls and instrumentation, has been completely erected, the Contractor shall notify the Engineer, who will designate a time to make such tests as required, and operate the item to the satisfaction of the Engineer. All testing shall be done in the presence of the Engineer or Resident Project Representative. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned and painted.
- G. Pressure Test:
1. After installation, all piping shall be pressure tested. Piping shall be tested in accordance with Section 15044: Pressure Testing of Piping.
 2. All tests shall be made in the presence of and to the satisfaction of the Engineer and also, to the satisfaction of any local or state inspector having jurisdiction.

- a. Provide not less than three days notice to the Engineer and the authority having jurisdiction when it is proposed to make the tests.
 - b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.
 - c. The piping systems may be tested in sections as the Work progresses by no joint or portion of the system shall be left untested.
3. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.
 4. All defects and leaks observed during the tests shall be corrected and made tight in an approved manner and the tests repeated until the system is proven tight.
 5. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.
 6. Provide test pumps, gauges, or other instruments and equipment required for the performance of all tests. Provide all temporary bracing, test plugs, additional restraint, and thrust blocking which may be required for test pressures above normal working pressures.
 7. All tests shall be maintained for as long a time as required to detect all defects and leaks but not less than the duration specified for each type of pipe or piping system in this Division.

H. Failure of Test:

1. Defects: Any defects in the equipment, or deviations from the guarantees or requirements of the Specifications, shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails to correct any defects or deviations, or if the replaced equipment when tested shall fail again to meet the guarantees or specified requirements, the City, notwithstanding his having made partial payment for work and materials which have entered into the manufacturer for such equipment, may reject that equipment and order the Contractor to remove it from the premises at the Contractor's expense.
2. Rejection of Equipment: In case the City rejects a particular item of equipment, then the Contractor hereby agrees to repay to the City all sums of money paid to him to deliver to the Contractor a bill of sale of all his

rights, title, and interest in and to the rejected equipment provided, however that the equipment shall not be removed from the premises until the City obtains from other sources other equipment to take the place of that rejected. The bill of sale shall not abrogate the City's right to recover damages for delays, losses or other conditions arising out of the basic Contract. The City hereby agrees to obtain the alternate equipment within a reasonable time and the Contractor agrees that the City may use the original equipment furnished by him without rental or other charge until the other equipment is obtained.

- I. Responsibility During Tests: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the City formally takes over the operation thereof.
- J. Acceptance of Materials:
 - 1. Only new materials and equipment shall be incorporated in the Work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the City. No material shall be delivered to the Work without prior submittal approval of the Engineer.
 - 2. The Contractor shall submit to the Engineer data relating to materials and equipment he proposes to furnish for the Work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the Specifications.
 - 3. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the Work, the Contractor shall submit samples of materials for such special test as may be necessary to demonstrate that they conform to the Specifications. Such sample shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, the City will make arrangements for and pay for tests.
 - 4. The Contractor shall submit data and samples sufficiently early to permit consideration and acceptance before materials are necessary for incorporation in the Work.
- K. Safety Requirements:
 - 1. In addition to the components shown and specified, all machinery and equipment shall be safeguarded in accordance with the safety features required by the current codes and regulations of ANSI, OSHA, and local industrial codes.

2. The Contractor shall provide for each exposed V-belt drive or rotating shaft a protective guard which shall be securely bolted to the floor or apparatus. The guard shall completely enclose drives and pulleys and be constructed to comply with all applicable safety requirements.

1.03 SUBMITTALS

- A. Submit to the Engineer in accordance with Section 01340.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packaging: All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.
- B. Protection: All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.
- C. Lubrication: Grease and lubricating oil shall be applied to all bearings and similar items as necessary to prevent damage during shipment and storage.
- D. Marking: Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.
- E. Fabricated sub-assemblies, if any, shall be shipped in convenient sections as permitted by carrier regulations and shall be properly match-marked for ease of field erection.
- F. Responsibility:
 1. The Contractor shall be responsible for all material, equipment, and supplies sold and delivered to the site under this Contract until final acceptance of the Work by the City. In the event any such material, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the Contractor shall replace same without additional cost to the City.
 2. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven days after written

notice to do so has been given, the City retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the Contractor's Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.

G. Delivery: The Contractor shall arrange deliveries of products in accordance with construction schedules and coordinate to avoid conflict with work and conditions at the site.

1. The Contractor shall deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
2. Immediately on delivery, the Contractor shall inspect shipments to assure compliance with requirements of Contract Documents and accepted submittals, and that products are properly protected and undamaged.
3. Under no circumstances shall the Contractor deliver equipment to the site more than one month prior to installation without written authorization from the Engineer. Operation and maintenance data shall be submitted to the Engineer for review prior to shipment of equipment as described in Section 01730 – Operating and Maintenance Data.

H. Storage and Protection of Products:

1. The Contractor shall furnish a covered, weather-protected storage structure providing clean, dry noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the "Instructions for Storage" of each equipment supplier and manufacturer furnished and installed including connection of space heaters, and placing stored lubricants in equipment. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.
 - a. The Contractor shall store products subject to damage by the elements in weathertight enclosures.
 - b. The Contractor shall maintain temperature and humidity within the ranges required by manufacturer's instructions.
 - c. The Contractor shall store fabricated products above the ground, on blocking or skids, to prevent soiling or staining. The Contractor shall

cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation to avoid condensation.

- d. The Contractor shall store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.
2. All materials and equipment to be incorporated in the Work shall be handled and stored by the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind whatsoever to the material or equipment.
3. Cement, sand, and lime shall be stored under a roof and off the ground, and shall be kept completely dry at all times. All structural and miscellaneous steel and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease, and in a position to prevent accumulations of standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking, and spalling to a minimum.
4. All materials which, in the opinion of the Engineer, have become damaged and are unfit for the use intended or specified shall be promptly removed from the site of the Work and the Contractor shall receive no compensation for the damaged material or its removal.
5. The Contractor shall arrange storage in a manner to provide easy access for inspection. The Contractor shall make periodic inspections of stored products to assure products are maintained under specified conditions, and free from damage or deterioration.
6. Protection After Installation: The Contractor shall provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. The Contractor shall remove covering when no longer needed.
- I. Extended Storage Requirements For Equipment: Because of the long period allowed for construction, special attention shall be given to extended storage and handling of equipment onsite. As a minimum, the procedure specified herein shall be followed:
 1. If equipment will be stored onsite for more than one month prior to incorporation into the Work, the Contractor shall submit a written request to the Engineer outlining any special provision to be made to protect and maintain the equipment while it is being stored. All such provisions shall be acceptable to the City. No equipment shall be stored onsite for more than one month without prior written authorization from the Engineer.

2. All equipment having moving parts including gears, electric motors, and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Engineer, until such time as the equipment is to be installed.
3. All equipment shall be stored fully lubricated with oil and grease unless otherwise instructed by the manufacturer.
4. Manufacturer's storage instructions shall be carefully studied by the Contractor and reviewed by him with the Engineer. These instructions shall be carefully followed and a written record of this review kept by the Contractor.
5. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment the Contractor shall start the equipment and operate, loaded when possible, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and final acceptance. Mechanical equipment to be used in the Work, if stored for longer than ninety (90) days, shall have the bearings cleaned, flushed, and lubricated prior to testing and startup, at no extra cost to the City.
7. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equivalent to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective, and it shall be removed and replaced at the Contractor's expense.
8. A maintenance log shall be maintained by the Contractor outlining the schedule of maintenance required for each piece of equipment as well as the date on which the maintenance was actually performed and the initials of the individual performing the Work. Submit a copy of the maintenance log monthly with the progress pay application.

1.05 WARRANTY AND GUARANTEES

- A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740 - Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year after the time of completion and acceptance.

1.06 SPARE PARTS

- A. The Contractor shall collect and store all spare parts in an area to be designated by the Engineer. In addition, the Contractor shall furnish to the Engineer an inventory listing of all spare parts, the equipment they are associated with, and the name and address of the supplier.

1.07 MAINTENANCE MATERIALS

- A. All grease, oil, and fuel required for testing of equipment shall be furnished by the Contractor with the respective equipment. The City shall be furnished with a year's supply of required lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied.
- B. The Contractor shall be responsible for changing the oil in all drives and intermediate drives of each mechanical equipment after initial break-in of the equipment, which in no event shall be any longer than three weeks of operation.

PART 2 - PRODUCTS

2.01 FABRICATION AND MANUFACTURE

- A. Workmanship and Materials:
 - 1. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure. Materials shall be suitable for service conditions.
 - 2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
 - 3. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least ¼-inch thick.

B. Lubrication:

1. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.
2. Lubricants of the type recommended by the equipment manufacturer shall be furnished by the Contractor in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by City. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.
3. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

C. Equipment Foundation Supports:

1. All foundations, platforms and hangers required for the proper installation of equipment shall be furnished and installed by the Contractor.
2. Unless otherwise indicated or specified, all equipment shall be installed on reinforced concrete bases at least 6-inch high and shall conform to Section 03300 - Cast-In-Place Concrete. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts. All open equipment bases shall be filled with nonshrinking grout sloped to drain to the perimeter of the base.
3. The Contractor shall furnish, install and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of equipment. These shall be of ample size and strength for the purpose intended.

D. Shop Painting:

1. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop. Surfaces which will be inaccessible after assembly shall

be protected for the life of the equipment. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with a high-grade oil-resistant enamel suitable for coating in the field with an alkyd enamel. Coatings shall be suitable for the environment where the equipment is installed.

2. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Unless otherwise specified, the shop primer for steel and iron surfaces shall in accordance with Section 09900 – Painting and Coating.
 3. Unless otherwise noted or recommended by the manufacturer, machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, Houghton "Rust Veto 344", Rust-Oleum "R-9", or equivalent.
- E. Nameplates: Contractor shall provide equipment identification nameplates for each item of equipment in accordance with Section 09905 - Piping, Valve, and Equipment Identification System.
- F. Noise Attenuation and Control:
1. Unless otherwise specified, the maximum permissible noise level for a complete installed piece of equipment located within or outside a structure shall not exceed 85-dB at 3-feet. A complete piece of equipment includes the driver and driven equipment, plus any intermediate couplings, gears, and auxiliaries. All equipment provided herein that is specified to be factory and field tested shall be tested as specified herein for noise generation at the equipment manufacturer's expense.
 2. Maximum permissible noise (sound pressure) levels shall be in decibels as read on the "A" weighting scale of a standard sound level meter (dB); all measurements shall be made in relation to a reference pressure of 0.0002-microbar. Measurements of emitted noise levels shall be made on a sound level meter meeting at least the Type 2 requirements set forth in ANSI/ASA S1.4, Specification for Sound Level Meters. The sound level meter shall be set on the "A" scale and to slow response. Unless otherwise specified for a particular piece of equipment, the point of measurement of sound level shall be made at the specified distance from any major surface along the entire perimeter and at midheight of the piece of equipment, or at the specified distance from an outer major surface encompassing the sound source including inlets or outlets.

G. Fire Hazard Rating:

1. All piping, fastener, and jacketing materials shall have a fire hazard rating not to exceed 25 for flame spread, 50 for fuel contributed, and 50 for smoke developed. Rating shall be determined by ASTM Designation E84, "Surface Burning Characteristics of Building Materials". Corresponding ratings determined by Underwriters' Laboratories, Inc., UL-723, "Test Method for Fire Hazard Classification of Building Materials", will also be acceptable.
2. Flameproofing treatments will not be acceptable.

2.02 ACCESSORIES

- A. Special Tools and Accessories: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
- B. Fasteners: All nuts, bolts, anchors and other fastening devices shall be a minimum of 304 stainless steel unless otherwise specified. If the nuts, bolts, anchors, and other fastening devices are subject to corrosive environments they shall be a minimum of 316 stainless steel unless otherwise specified.

PART 3 - EXECUTION

3.01 INSTALLATION AND OPERATION

A. Installation

1. Pipe and Fittings
 - a. Trenches shall be maintained in a dry condition at all times unless otherwise approved by the Engineer.
 - b. Swabs shall be installed during installation for flushing purposes.
 - c. Maintain horizontal and separation of water from sewer and stormwater piping in accordance with the FDEP requirements. Sewer should always be below water on vertical separations.
 - d. Install pipe to indicated elevation to within tolerance of $\frac{5}{8}$ -inches. Minimum cover shall be 36-inches unless otherwise stipulated or authorized by the City.
 - e. Install DIP and fittings to comply with requirements of AWWA C600. Install PVC Piping to comply with Uni-B-3 recommended practices.

Install HDPE piping to comply with Mini-Horizontal Directional Drilling Manual. All tapping shall be done with a tapping machine designed for this specific service. All pipe cutting shall be accomplished by power-operated abrasive wheel or saw cutters.

- f. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- g. Install access fittings to permit the disinfection for potable water system.
- h. All fittings and valves shall be restrained with megalug or equal retainer glands. All stubs shall be restrained with a minimum of 80-lineal feet of pipe beyond the valve. Where this is not possible, utilize City approved retaining glands.
- i. Identification of buried piping shall be in accordance with Section 09905 – Piping, Valve, and Equipment Identification System.
- j. Pipe shall be laid in a level trench. Hand trim excavation for accurate placement of pipe to elevations indicated. The width of trenches for installation of all lines shall be in accordance with the pipe manufacturer recommendations, OSHA safety requirements, and all applicable codes. Trench widths shall not be less than necessary for safe and proper construction. Where required, excavation support systems shall be provided.
- k. Installation and restoration operation under roads, shoulders or other level areas shall be performed in compliance with any local, County or State requirements, which ever may apply.
- l. Every effort shall be made to cover pipe ends during installation and a watertight plug or other approved seal must be used when installation is not in progress.
- m. The inspector, to minimize public inconvenience or danger to life or property, may limit length of an open trench on existing roads.
- n. At the completion of pipe installation, contractor must pig lines to clean and remove any foreign debris from potable water piping main prior to doing disinfection. For wastewater piping lines must be cleaned and free of any foreign debris.

2. Connections to Existing Lines

- a. Where connections are required to be made between new piping and existing piping, the connection shall be made in a thorough and workmanlike manner using proper materials, fittings, and labor practices to suit the existing materials and conditions.

- b. Where a connection is made to an existing fitting, the contractor shall schedule his work so that the excavation and location of this existing fitting can be completed prior to starting trench work on the line.
 - c. The Contractor under the direction of the City shall do all taps to existing lines in the presence of the City's Utilities Inspector, unless otherwise approved.
 - d. Whenever it is required to interrupt existing water supplies to residences or businesses, the contractor shall notify all concerned parties or agencies at least 72 hours in advance of such cut-off. Contractor must first obtain approval from the City.
- B. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of Contractor or his subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.
 - 1. The Contractor shall have on site sufficient proper construction equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory assembled when practical.
 - 2. Equipment shall be erected in a neat and workmanlike manner on the foundations and supports at the locations and elevations shown on the Contract Drawings, unless otherwise directed by the Engineer during installation.
 - 3. All equipment shall be installed in such a manner as to provide access for routine maintenance including lubrication.
 - 4. For equipment which require field alignment and connections, the Contractor shall provide the services of the equipment manufacturer's qualified mechanic, millwright, machinist, or authorized representative.
 - 5. Equipment of a portable nature which requires no installation shall be delivered to a location designated by the City.
- C. Tolerances: Precision gauges and levels shall be used in setting all equipment. All piping and equipment shall be perfectly aligned, horizontally and vertically. Tolerances for piping and equipment installation shall be ½-inch to 30-feet horizontal and vertically. All valves and operators shall be installed in the position shown on the Contract Drawings or as directed by the Engineer, if not shown.

- D. Alignment and Level: The equipment shall be brought to proper level by shims (¼-inch maximum). After the machine has been leveled and aligned, the nuts on the anchor bolts shall be tightened to bind the machine firmly into place against the wedges or shims.
- E. Grouting: The grout shall be tamped into position with a board, steel bar, or other tool. Tamping should not be so hard as to raise or otherwise displace the plate.
- F. Contact of Dissimilar Metals: Where the contact of dissimilar metal may cause electrolysis and where aluminum will contact concrete, mortar, or plaster, the contact surface of the metals shall be separated using not less than one coat of zinc chromate primer and one heavy coat of aluminum pigmented asphalt paint on each surface.
- G. Cutting and Patching: All cutting and patching necessary for the Work shall be performed by the Contractor.
- H. Operation: All equipment installed under this Contract, including that furnished by City or others under separate contract, shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.

3.02 TESTING

- A. When the equipment is specified to be factory tested, the results of the tests shall be submitted to the Engineer and approval of the test results shall be obtained before shipment of the equipment.
- B. When an item of equipment, including controls and instrumentation, has been completely erected, the Contractor shall notify the Engineer, who will designate a time to make such tests as required, and operate the item to the satisfaction of the Engineer. All testing shall be done in the presence of the Engineer or Resident Project Representative. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned and painted.
- C. Pressure Test: Pressure testing for piping shall be performed in accordance with Section 15044 – Pressure Testing of Piping.
- D. Failure of Test:
 - 1. Defects: Any defects in the equipment, or deviations from the guarantees or requirements of the Specifications, shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the

Contract shall be final and conclusive. If the Contractor fails to correct any defects or deviations, or if the replaced equipment when tested shall fail again to meet the guarantees or specified requirements, the City, notwithstanding his having made partial payment for work and materials which have entered into the manufacturer for such equipment, may reject that equipment and order the Contractor to remove it from the premises at the Contractor's expense.

2. Rejection of Equipment: In case the City rejects a particular item of equipment, then the Contractor hereby agrees to repay to the City all sums of money paid to him to deliver to the Contractor a bill of sale of all his rights, title, and interest in and to the rejected equipment provided, however that the equipment shall not be removed from the premises until the City obtains from other sources other equipment to take the place of that rejected. The bill of sale shall not abrogate the City's right to recover damages for delays, losses or other conditions arising out of the basic Contract. The City hereby agrees to obtain the alternate equipment within a reasonable time and the Contractor agrees that the City may use the original equipment furnished by him without rental or other charge until the other equipment is obtained.

- E. Responsibility During Tests: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the City formally takes over the operation thereof.

3.03 OBSERVATION OF PERFORMANCE TESTS

- A. Where the specifications require observation of performance tests by the Engineer or Resident Project Representative, such tests shall comply with the quality assurance paragraph in this Section.

3.04 DISINFECTION

- A. General: Before being placed in service, all potable water pipelines shall be disinfected by chlorination. Taps for chlorination and sampling shall be uncovered and backfilled by the Contractor as required. The disinfection procedure shall be approved by the Engineer.
- B. Procedures to be used shall conform to AWWA Standard C651. Pertinent requirements are as follow:
 1. Chlorine solution shall be added to ensure a 50-PPM residual in all portions of the system. Inspector may designate points where residual is measured.
 2. Retention time shall be not less than 24 hours.

3. A minimum of 25-PPM chlorine residual must remain at the end of the 24 hour period.
4. Chlorine may be used in the following forms:
 - a. Liquid chlorine as gas/water mixture through an approved solution-feeding device.
 - b. Sodium Hypochlorite in a packaged liquid form with 5 percent (5%) to 15 percent (15%) available chlorine.
 - c. Calcium Hypochlorite in a dry form (powder or tablets) with 80 percent (80%) available solution such as HTH or Perchloron.
- C. After the disinfection process has been completed; all lines shall be thoroughly flushed to a condition equal to the normal base residual.
- D. Copies of satisfactory bacteriological analysis (a.k.a. Main Clearance) must be taken within 45 days of completion of construction, from representative points within the distribution system to be cleared. Samples shall be taken on two consecutive days at least 6 hours apart with sample location and chlorine residual readings clearly indicated on report (AWWA 651). Such sample points should include:
 1. One (1) set of samples from every 1,200-feet of the new water main. In case where the new water main is subaqueous or is horizontal directional drill or Jack & Bore, a set of samples shall be taken at the beginning and end point of where the new water main connects to the open trench or other accessible installation method that is in accordance these Project Specifications and Contract Documents.
 2. One (1) set from the end of the line (each line).
 3. One (1) set from each branch.
 4. One (1) set from connection of proposed to exist.
- E. Approval: The line shall not be placed in service until the requirements of the State and County Public Health Department are met, and the Letter of Clearance is obtained from the FDEP and the Broward County Health Department.

3.05 MANUFACTURER'S FIELD SERVICES

- A. Services Furnished Under This Contract:

1. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.
2. Each manufacturer's representative shall furnish to City and Engineer a letter of certification stating that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.
3. All costs for field services shall be included in the contract amount.

END OF SECTION

SECTION 33 05 19

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all labor, materials (US manufactured), equipment and incidentals required and install, in the locations inside, and under buildings and structures as shown on the Contract Drawings, all ductile iron piping, ductile iron fittings, and appurtenances as specified herein.
- B. General Design: The equipment and materials specified herein is intended to be standard types of ductile iron pipe and ductile iron fittings for use in transporting raw water, potable water, and reject water (reject water requires 401 coating).

1.02 QUALITY ASSURANCE

- A. Qualifications: All of the ductile iron pipe and ductile iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with these specifications as applicable.
- B. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American National Standards Institute (ANSI)
 - a. ANSI/MSS SP58 – Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
 - 2. American Water Works Association (AWWA)
 - a. AWWA/ANSI C104/A21.4 – Cement Mortar Lining for Ductile-Iron Pipe and Fittings
 - b. AWWA/ANSI C105/A21.5 – Polyethylene Encasement for Ductile-Iron Pipe Systems
 - c. AWWA/ANSI C110/A21.10 – Ductile-Iron and Grey-Iron Fittings
 - d. AWWA/ANSI C111/A21.11 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

- e. AWWA/ANSI C115/A21.15 – AWWA Standard for Flanged Ductile-Iron Pipe with Threaded Flanges
 - f. AWWA/ANSI C150/A21.50 – Thickness Design of Ductile-Iron Pipe
 - g. AWWA/ANSI C151/A21.51 – Ductile Iron Pipe, Centrifugally Cast
 - h. AWWA/ANSI C153/A21.53 – Ductile-Iron Compact Fittings
 - i. AWWA C600 – Installation of Ductile Iron Water Mains and Their Appurtenances
 - j. AWWA C651 – Disinfecting Water Mains
- 3. American Society of Mechanical Engineers (ASME)
 - a. ANSI/ASME B16.1 and B16.5 – Pipe Flanges and Flanged Fittings Package
- 4. American Society for Testing Materials (ASTM)
 - a. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - b. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
- 5. NSF International
 - a. NSF/ANSI 61 - Drinking Water System Components
- 6. Where reference is made to standards of one (1) of the above, or other originations, the latest edition or version shall apply.
- C. Factory Tests: The manufacturer shall perform the factory tests described in ANSI A-21.51/AWWA C151.
- D. Quality Control
 - 1. The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with the referenced standards.
 - 2. In addition to the manufacturer's quality control procedures, the City may select an independent testing laboratory to inspect the material at the

foundry for compliance with these specifications. The cost of foundry inspection requested by the City will be paid for by the City.

1.03 SUBMITTALS

- A. Submit to the Engineer in accordance with Section 01340 – Shop Drawings, Work Drawings, and Samples.
- B. Materials and Shop Drawings: Submit shop drawings, including pipeline layouts, within and under buildings and structures. Shop drawings shall include dimensioning, methods and locations of supports and all other pertinent technical specifications. Shop drawings shall be prepared by the pipe manufacturer. Shop drawings for piping within and under buildings and structures shall be submitted within 30 days of Execution of Contract.
- C. Operating Instructions: Submit Operation and Maintenance Manuals in accordance with Section 01730 – Operating and Maintenance Data.
- D. Manufacturer's Certification: Submit certification of compliance with the following, sworn by a corporate officer of the manufacturer and witnessed by a notary.
 - 1. Factory tests and results
 - 2. Dimensions and weights of fittings per respective AWWA Standard.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery and Storage: Delivery and storage of the materials shall be in accordance with the manufacturer's recommendations.
- B. Handling: Care shall be taken in loading, transporting and unloading to prevent damage to the pipe or fittings and their respective coatings. Pipe or fittings shall not be rolled off the carrier or dropped. Unloading shall be done by lifting with a forklift or crane. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE

- A. Ductile Iron Pipe: Equipment Manufacturers shall be American Cast Iron Pipe Co., U.S. Pipe, or an approved equal by the Engineer.
 - 1. Standards: AWWA/ANSI C150/A21.50 and AWWA/ANSI C151/A21.51

2. Thickness:

- a. Below ground piping: Pipes shall be the following minimum thickness class unless otherwise noted or specified.

(1) 12-inch or smaller (unless otherwise noted or specified)

Pressure Class 350

(2) 14 to 20-inch diameter

Pressure Class 250

(3) 24-inch diameter

Pressure Class 200

(4) 30 to 64-inch diameter

Pressure Class 150

(5) Above Ground Piping

Flanged, Pressure Class 53 (Minimum)

2.02 JOINT AND FITTINGS

A. Joints:

1. Push-on or Mechanical Joints (below ground piping):

a. Standards: AWWA/ANSI C111/A21.11

b. Class: The working pressure of the joint shall be equivalent to or exceed the rated working pressure of the pipe.

c. Gaskets: SBR (Styrene Butadiene Rubber)

2. Flanged (above ground or inside below ground vaults):

a. Standards: AWWA/ANSI C115/A21.15, ANSI/ASME B16.1

b. Class: 125-lb factory applied screwed long hub flanges, plain faced without projection.

c. Gaskets:

(1) Spans less than 10-feet: full face 1/8-inch thick neoprene rubber

(2) Spans greater than 10-feet: Toroseal gaskets as manufactured by American Cast Iron Pipe or an approved equal by Engineer.

3. Restrained Joints:

- a. "Manufactured": "Flex-Ring" or "Lok-Ring" restrained joint system as manufactured by American Ductile Iron Pipe, or an approved equal by the engineer.
- b. "Gasket": "Fast-Grip" as manufactured by American Ductile Iron Pipe or "Field Lok" as manufactured by U.S. Pipe or an approved equal by Engineer.

(1) May be used only for pipe sizes 4-inch through 24-inch on straight runs of pipe.

(2) Shall not be used for:

- i Fittings
- ii Within bore and jack casings
- c. "Mechanical" Restraining Devices: Meg-a-Lug system as manufactured by EBBA Iron or an approved equal by the Engineer.
- d. Class: 250-psi (minimum) design pressure rating
- e. Standard mechanical joint retainer glands will not be acceptable.

4. Grooved Joint Pipe Fittings

- a. Provided as indicated on the Contract Drawings.
- b. Manufacture: Victaulic or Gruvlock.
- c. Gaskets shall be certified for NSF/ANSI 61 for potable water service.

5. Joint Accessories

- a. Mechanical joint bolts, washers and nuts: Ductile iron or Corten steel.
- b. Flanged joint bolts, washers and nuts:
 - (1) Above Ground: Hot dipped galvanized, Grade B, ASTM A307
 - (2) Below Ground: AISI Type 304 stainless steel

6. Pipe Length (below ground installation): 20-feet maximum nominal length.

B. Fittings:

1. Materials: Ductile iron, AWWA C110
2. Pressure Class
 - a. Mechanical Joint, Restrained Joint: Minimum 250-psi pressure rating.
 - b. Flanged Joint: Class 125, plain
3. Compact Fittings: AWWA/ANSI C153/A21.53 (4-inch through 24-inch diameter only)

C. Wall Penetrations (Cast-In-Place Walls):

1. Wall Pipes:
 - a. Material: Ductile iron
 - b. Type: Welded-on wall collar/water stop located in the center of the wall.
 - c. Design: Full thrust at 250-psi transmitted to the structure wall. Tapped mechanical joint wall pipes may be used to facilitate concrete form work.
2. Wall Sleeves:
 - a. Material: Galvanized Schedule 40 Steel Pipe, ASTM A53/A53M
 - b. Design: as manufactured by GPT, "Link Seal" or an approved equal by the Engineer.

2.03 COATINGS, MARKINGS AND LININGS

A. Exterior Coatings:

1. Below ground or in a casing pipe:
 - a. Type: Asphaltic coating, 1- mil DFT
 - b. Piping identification markings and Tape shall be in accordance with Section 09905 – Piping, Valve and Equipment Identification system.
2. Aboveground:
 - a. Not subject to non-potable water submergence or splashing.

- b. Subject to non-potable water submergence or splashing.
 - c. Piping shall be color coded in accordance with Section 09900 – Painting and Coating.
 - d. Identification shall be in accordance with 09905 – Piping, Valve and Equipment Identification system.
- B. Interior Lining (Applied by pipe manufacturer):
 - 1. Concentrate Service: Ductile iron pipe, fittings, and specials shall be lined with Protecto 401 Ceramic Epoxy, a high build multi-component amine cured Novolac epoxy lining, containing at least 20 percent (20%) by volume of ceramic quartz pigment, manufactured by Induron Coatings, Inc. or an approved equal by the Engineer. The interiors of the ductile iron pipe, fittings, and specials shall receive 40-mils DFT of the ceramic epoxy protective lining. Storage, surface preparation, application, and safety precautions shall strictly follow manufacturer's instructions.
 - 2. Potable Water Service: Ductile iron pipe and fittings for potable water service shall have a cement mortar lining in accordance with AWWA/ANSI C104/A21.4. The lining shall be listed by NSF/ANSI 61 for potable water contact.
 - 3. Reclaimed Water: Ductile iron pipe and fittings shall have a cement mortar lining with a seal coat of asphaltic material in accordance with AWWA/ANSI C104/A21.4.
 - 4. Process Air: Ductile iron pipe and fittings for process air service shall be unlined.
- C. Polyethylene Encasement (required for all below ground piping, fittings and appurtenances located less than 10-feet from a gas main and as indicated on the Contract Drawings):
 - 1. Standard: AWWA/ANSI C105/A21.5, 8-mil DFT minimum thickness.
 - 2. Color: Color coded per paragraph A. above.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All pipes shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the City or Engineer.
- B. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify City or Engineer immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color and type.
- C. Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23 forklift with chisel forks shall be used to off-load the pipe. The fork chisel should be checked to be sure it is not thicker than the gap between the units of pipe strapped together for shipping and handling purposes. Extend forks to remove each top unit from the truck. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
- D. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
- E. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces.
- F. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.
- G. Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the City or Engineer. Any scratch or gouge greater than 10 percent (10%) of the wall thickness will be considered significant and can be rejected unless determined acceptable by the City or Engineer.
- H. Pipe shall be handled and supported with the use of woven fiber pipe slings or an approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way. Use of hooks, chains, wire rope or any other handling device which creates the opportunity to damage the surface of the pipe is strictly prohibited.
- I. After delivery to the project site, pipe shall be stored at ambient temperature and protected from ultraviolet light degradation. If pipe is to be stored for periods of 6 months or longer, the pipe must be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting

adequate air circulation above and around the pipe as required to prevent excess heat accumulation.

- J. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.
- K. Racks or dunnage to prevent damage to the bottom of the pipe during storage should support the pipe lengths. Supports should be spaced to prevent pipe bending and deformation. The pipe shall be stored in stacks no higher than that given in the following table:

<u>Pipe Diameter (inches)</u>	<u>Max. No. of Rows Stacked</u>
8 or less	5
12 to 21	4
24 to 30	3
33 to 48	2

- L. In preparation for pipe installation, placement of pipe should be as close to the installation area as practical.

3.02 INSTALLATION

- A. Standards: AWWA C600, latest edition
- B. Underground Ductile Iron Pipe and Fittings:
 - 1. Bedding for Ductile Iron Pipe: Minimum bedding requirements shall be Type 4 as defined in ANSI/AWWA C600, latest revision. Provide proper bedding required, in accordance with thickness class of pipe being laid and depth of cover. Pipe laying conditions shall be in accordance with ANSI/AWWA C150 and C151, latest revisions, and ANSI/AWWA C600, latest revision.
 - 2. Placement: Alignment: In accordance with lines and grades shown on the Contract Drawings. Deflection of joints shall not exceed 75 percent (75%) of that recommended by the manufacturer.
 - 3. Cutting: When required, cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of the pipe to be used with a push-on bell shall be beveled.
 - 4. Joints:
 - a. Joint Placement:

(1) Push on joints: Pipe shall be laid with the bell ends facing upstream. The gasket shall be inserted and the joint surfaces cleaned and lubricated prior to placement of the pipe. After joining the pipe, a metal feeler shall be used to verify that the gasket is correctly located.

(2) Mechanical Joints: Pipe and fittings shall be installed in accordance with the "Notes on Method of Installation" under AWWA/ANSI C111/A21.11. The gasket shall be inserted and the joint surfaces cleaned and lubricated with soapy water before tightening the bolts to the specified torque.

C. Aboveground and interior ductile iron pipe and fittings

1. Pipe Supports:

a. General: All piping shall be properly supported with hangers, supports, base elbows and tees, concrete piers and pads as shown on the Contract Drawings and in accordance with Section 15126 – Hangers and Supports. All pipe and appurtenances connected to equipment shall be supported to prevent any strain from being imposed on the equipment.

b. Support spacing: 8-feet on centers and at each fitting and where shown on the Contract Drawings.

c. Hangers for Horizontal Piping

(1) Material: Heavy malleable iron

(2) Type: Adjustable, swivel, split ring or adjustable swivel, pipe-roll

d. Hangers for vertical piping

(1) Material: Wrought Iron

(2) Type: Clamp

e. Pipe supports shall be installed in accordance with ANSI/MSS SP58.

2. Placement

a. Alignment: In accordance with lines and grades shown on the Contract Drawings. Each section of pipe shall be cleaned thoroughly prior to installation.

3. Flanged Joints: Joints shall be fitted so that the contact faces bear uniformly on the gasket.

D. Thrust Restraint

1. General: Thrust restraint shall be accomplished by restrained joints.
2. Length of Restrained Joints: In accordance with the lengths shown on the Contract Drawings.

3.03 CLEANING

- A. General: At the conclusion of the work, the Contractor shall thoroughly clean the new pipe lines by flushing with water or other means to remove all dirt, stones or other material which may have entered the line during the construction period.
- B. Correction of Non-Conforming Work: All non-conforming work shall be repaired or replaced by the Contractor at no additional expense to the City. Non-conforming work shall be defined as failure to adhere to any specific or implied directive of these Project Specifications and/or the Contract Drawings, including but not limited to pipe not laid straight, true to the lines and grades as shown on the Contract Drawings, damaged or unacceptable materials, misalignment or diameter ring deflection in pipe due to bedding or backfilling, visible or detectable leakage and failure to pass any specified test or inspection.

3.04 FIELD TESTING

- A. General: At least ten (10) days prior to beginning testing, the Contractor shall submit a testing plan to the Engineer for review. A 48 hour notice must be provided to City prior to performance of any testing.
- B. Pressure Piping:
 1. General: The Contractor shall perform hydrostatic pressure and leakage tests on all pressure piping in accordance with Section 15044 - Pressure Testing of Piping.
 2. Standard: AWWA C600, Section 4, with the exceptions required herein and the exception that the Contractor shall furnish all gauges, meters, pressure pumps and other equipment needed to test the lines.

3.05 DISINFECTION OF POTABLE WATER PIPELINES

- A. General: The Contractor shall perform hydrostatic pressure and leakage tests on all pressure piping in accordance with Section 15000 – Mechanical – General Requirements.

END OF SECTION

SECTION 33 05 31

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS (LARGER THAN 2-INCH)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all labor, materials, equipment and incidentals required and install and test all polyvinyl chloride (PVC) piping, fittings and appurtenances as shown on the Contract Drawings and specified herein.
- B. General Design: The equipment and materials specified herein is intended to be standard types of PVC pipe and cast or ductile iron fittings for use in transporting wastewater, sludge, potable water, and reclaimed water.

1.02 QUALITY ASSURANCE

- A. Qualifications: All of the PVC pipe and cast or ductile iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with these specifications as applicable.
- B. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM A536 – Standard Specification for Ductile Iron Castings
 - b. ASTM D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
 - c. ASTM D1869 – Standard Specification for Rubber Rings for Fiber-Reinforced Cement Pipe
 - d. ASTM D2241 – Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
 - e. ASTM D2564 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

- f. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
 - g. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
 - h. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- 2. American Water Works Association (AWWA)
 - a. AWWA/ANSI C110/A21.10 – Ductile-Iron and Grey-Iron Fittings
 - b. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
 - c. AWWA C900 C900-07 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. for Water Transmission and Distribution
 - d. AWWA C905 - AWWA C905-10 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. for Water Transmission and Distribution
 - e. AWWA Manual of Practice 23 (M23) – PVC Pipe – Design and Installation
- 3. NSF International
 - a. NSF/ANSI 14 – Plastic Piping System Components and Related Materials
 - b. NSF/ANSI 61 - Drinking Water System Components
- 4. Uni-Bell PVC Pipe Association
 - a. UNI-B-1 – Recommended Specifications for Thermoplastic Pipe Joints, Pressure and Non-Pressure Applications
- 5. Where reference is made to standards of one (1) of the above, or other originations, the latest edition or version shall apply.
- C. Factory Tests: The manufacturer shall perform the factory tests described in AWWA C900/C905.

D. Quality Control

1. The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with the referenced standards.
2. In addition to the manufacturer's quality control procedures, the City may select an independent testing laboratory to inspect the material at the foundry for compliance with these specifications. The cost of foundry inspection requested by the City will be paid for by the City.

1.03 SUBMITTALS

- A. Materials and Shop Drawings: Submit shop drawings to the Engineer in accordance with Section 01340 – Shop Drawings, Work Drawings, and Samples. The location of all pipes shall conform to the Contract Drawings. In some cases, however, a certain amount of flexibility in pipe position will be allowed where new pipes connect to existing piping or when avoiding potential conflicts.
- B. Operating Instructions: Submit Operation and Maintenance Manuals in accordance with Section 01730 – Operating and Maintenance Data.
- C. Manufacturer's Certification: Submit sworn certification of factory tests and their results.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Polyvinyl Chloride (PVC) Pipe: Equipment manufactures shall be IPEX, Inc., North American Pipe Corporation or approved equal.
- B. Standards: AWWA C900 and C905/ASTM D1784/ASTM D2241. PVC pipe 4-inches diameter to 12-inches diameter shall be in accordance with AWWA C900, Class 150 with a minimum SDR of 18. PVC pipe large than 12-inches shall meet the requirements of AWWA C905, with a minimum of SDR of 18.
 1. Compounds: Class 12454-A or Class 12454-B.
 2. Dimension Ratio/Thickness: The wall thickness shall comply with the appropriate ASTM Specification and the class of pipe designated on the Drawings.
 3. Joints
 - a. Solvent weld (nominal diameter less than 4-inches)

(1) Standards: ASTM D2466/D2564

(2) Type: Slip Fitting Socket (tapered)

(3) Exclusions: Plastic saddle and flange joints will not be used.

b. Push-on integral bell (nominal diameter 4-inches or larger.)

(1) Standards: ASTM D3139 and F477/UNI-B-1

(2) Gaskets: Flexible elastomeric ring type

c. Pipe Length

(1) Pressure systems: 20-feet maximum nominal length.

C. Fittings - Pressure Systems (nominal diameter 4-inches or larger)

1. Materials: Ductile iron or grey cast iron, AWWA C110

2. Joints: Mechanical Joint, Minimum 250-psi pressure rating.

3. Gaskets: SBR (Styrene Butadine Rubber)

4. Compact Fittings: AWWA/ANSI C153/A21.53 (4-in through 24-in diameter only)

5. Exclusions: Standard double bell couplings will not be accepted where the pipe will slip completely through the coupling.

D. Restraint:

1. All underground piping installed by open trench shall have restrained joints.

2. Restraint devices for nominal pipe sizes 3-inch through 36-inch shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of AWWA/ANSI C110/A21.10.

3. Gland body, wedges and wedge actuating components shall be cast from Grade 65-45-12 ductile iron material in accordance with ASTM A536.

4. Thrust Restraint: Thrust restraint for PVC pipes shall be by ductile iron mechanical joint retainer glands for PVC as manufactured by U.S. Pipe Company, EBAA Iron, or Mueller Company.

2.02 LOCATION MARKINGS AND IDENTIFICATION

- A. Location markings and identification of buried and above ground piping shall be in accordance with Section 09905 – Piping, Valve and Equipment Identification System.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All pipes shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the City or Engineer.
- B. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify City or Engineer immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color and type.
- C. Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23. A forklift with chisel forks shall be used to off-load the pipe. The fork chisel should be checked to be sure it is not thicker than the gap between the units of pipe strapped together for shipping and handling purposes. Extend forks to remove each top unit from the truck. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
- D. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
- E. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces.
- F. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.
- G. Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the City or Engineer. Any scratch or gouge greater than 10 percent (10%) of the wall thickness will be considered significant and can be rejected unless determined acceptable by the City or Engineer.
- H. Pipe shall be handled and supported with the use of woven fiber pipe slings or an approved equal by the Engineer. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way. Use of hooks,

chains, wire rope or any other handling device which creates the opportunity to damage the surface of the pipe is strictly prohibited.

- I. After delivery to the project site, pipe shall be stored at ambient temperature and protected from ultraviolet light degradation. If pipe is to be stored for periods of 6 months or longer, the pipe must be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
- J. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.
- K. Racks or dunnage to prevent damage to the bottom of the pipe during storage should support the pipe lengths. Supports should be spaced to prevent pipe bending and deformation. The pipe shall be stored in stacks no higher than that given in the following table:

<u>Pipe Diameter (inches)</u>	<u>Max. No. of Rows Stacked</u>
8 or less	5
12 to 21	4
24 to 30	3
33 to 48	2

- L. In preparation for pipe installation, placement of pipe should be as close to the installation area as practical.

3.02 INSTALLATION

- A. Standards: AWWA C900 and C905/UNI-B 3.
- B. Underground PVC Pipe and Fittings:
 - 1. Bedding: Firm, dry and even bearing of suitable material. Blocking under the pipe will not be permitted.
 - 2. Placement/Alignment: In accordance with lines and grades shown on the Contract Drawings. For pressure systems, deflection of joints shall not exceed 75 percent (75%) of maximum limits recommended by the manufacturer and as set forth in applicable AWWA standards.

3. Cutting: When required, cutting shall be done leaving a smooth cut at right angles to the axis of the pipe. Cut ends of the pipe to be used with a push-on bell shall be beveled and clean.
4. Connection: For PVC water pipes 4 to 10-inch and larger shall be rubber compression ring type. Bell shall consist of an integral wall section with a solid cross-section elastomeric ring, which meets the requirements of ASTM D1869. Bell section shall be designed to be at least as strong as the pipe barrel.
5. Joints:
 - a. Joint Placement
 - (1) Push on Joints: Pipe shall be laid with the bell ends facing upstream. The gasket shall be inserted and the joint surfaces cleaned and lubricated prior to placement of the pipe. After joining the pipe, a metal feeler shall be used to verify that the gasket is correctly located.
 - (2) Mechanical Joints: Pipe and fittings shall be installed in accordance with the "Notes on Method of Installation" under AWWA/ANSI C111/A21.11. The gasket shall be inserted and the joint surfaces cleaned and lubricated with soapy water before tightening the bolts to the specified torque.

C. Thrust Restraint:

1. General: Thrust restraint shall be accomplished by restrained joints.
2. Length of Restrained Joints: In accordance with the lengths shown on the Contract Drawings.

3.03 CLEANING

- A. General: At the conclusion of the work, the Contractor shall thoroughly clean the new pipe lines by flushing with water or other means to remove all dirt, stones or other material which may have entered the line during the construction period.
- B. Correction of Non-Conforming Work: All non-conforming work shall be repaired or replaced by the Contractor at no additional expense to the City. Non-conforming work shall be defined as failure to adhere to any specific or implied directive of this Project Manual and/or the Contract Drawings, including but not limited to pipe not laid straight, not true to the lines and grades as shown on the Contract Drawings, damaged or unacceptable materials, misalignment or diameter ring deflection in

pipe due to bedding or backfilling, visible or detectable leakage and failure to pass any specified test or inspection.

3.04 PREPARATION FOR MAKING CONNECTIONS TO EXISTING PIPING SYSTEMS

- A. Approximate locations for existing piping systems are shown on the Contract Drawings or detailed in the specifications. Prior to making connections into existing piping systems, the Contractor shall:
 - 1. Field verify location, size, piping material and piping system of the existing pipe.
 - 2. Obtain all required existing piping manufacturer(s) approved fittings (i.e., saddles, sleeve type couplings, flanges, tees, etc., as shown).
 - 3. Have installed all temporary pumps and/or pipes in accordance with established connection plans.
 - 4. Have on hand necessary pipe stoppers, pancake flanges or other items which may be necessary should an existing valve or appurtenance fail to seal properly.
- B. Unless otherwise approved by the Engineer, new piping systems shall be completely assembled and successfully tested prior to making connections into existing pipe systems.

3.05 PIPE SYSTEM CONNECTIONS

- A. Pipe connections shall be installed per applicable standards and regulations, as well as per the connection manufacturer's recommendations and as indicated on the Contract Drawings. Pipe connections to structures shall be installed per applicable standards and regulations, as well as per the connection manufacturer's recommendations.

3.06 TRACER WIRE TESTING

- A. Upon completion of the directional bore, the Contractor shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.
 - 1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of the City or Engineer.
 - 2. If the wire is broken, the Contractor shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.07 TAPPING FOR POTABLE AND NON-POTABLE WATER APPLICATIONS

- A. Tapping shall be performed using standard tapping saddles designed for use on PVC piping in accordance with AWWA C605. Tapping shall be performed only with use of tap saddles or sleeves. No direct tapping will be permitted. Tapping shall be performed in accordance with the applicable sections for Saddle Tapping per Uni-Pub-8.
- B. Tapping sizes shall be limited to the following maximum diameters for the nominal pipe diameters as indicated below:
 - 1. Nominal pipe diameters 14-inch and under in size shall be limited to a maximum tapping diameter of 1-inch.
 - 2. Nominal pipe diameters 16 to 18-inch in size shall be limited to a maximum tapping diameter of 2-inch.
 - 3. Nominal pipe diameters 20 to 24-inch in size shall be limited to a maximum tapping diameter of 4-inch.
 - 4. Nominal pipe diameters 30-inch and larger in size shall be limited to a maximum tapping diameter of 6-inch.
- C. All other connections requiring a larger diameter shall be made with a pipe connection as specified and indicated on the Contract Drawings.
- D. Equipment used for tapping shall be made specifically for tapping PVC pipe:
 - 1. Tapping bits shall be slotted “shell” style cutters, specifically made for PVC pipe. ‘Hole saws’ made for cutting wood, steel, ductile iron, or other materials are strictly prohibited.
 - 2. Manually operated or power operated drilling machines may be used.
- E. Taps may be performed while the pipeline is filled with water and under pressure (‘wet’ tap), or when the pipeline is not filled with water and not under pressure (‘dry’ tap).

3.08 FIELD TESTING

- A. General: At least ten (10) days prior to beginning testing, the Contractor shall submit a testing plan to the Engineer for review. A 48-hour notice must be provided to City prior to performance of any testing.
- B. Pressure Piping:

1. General: The Contractor shall perform hydrostatic pressure and leakage tests on all pressure piping in accordance with Section 15044 – Pressure Testing of Piping.
2. Standard: AWWA C600, Section 4, with the exceptions required herein and the exception that the Contractor shall furnish all gauges, meters, pressure pumps and other equipment needed to test the lines.

3.09 DISINFECTION OF POTABLE WATER PIPELINES

- A. General: The Contractor shall perform hydrostatic pressure and leakage tests on all pressure piping in accordance with Section 15000 – Mechanical – General Requirements.

END OF SECTION

SECTION 33 05 33

POLYVINYL CHLORIDE (PVC) PIPE 2-INCH AND SMALLER IN DIAMETER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Place, joint and test all pipe, fittings, specials and appurtenances of a size 2-inch and smaller as shown on the Contract Drawings and specified herein.
- B. All 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.

1.02 QUALITY ASSURANCE

- A. Qualifications: All of the PVC pipe and cast or ductile iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with these specifications as applicable.
- B. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
 - b. ASTM D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
 - c. ASTM D2564 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
 - d. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
 - e. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
 - 2. NSF International Standard 61

3. NSF International Standard 14
4. UNI-B-1 through 3
- C. Factory Tests: The manufacturer shall perform the factory tests described in AWWA C900.
- D. Quality Control:
 1. The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with the referenced standards.
 2. In addition to the manufacturer's quality control procedures, the City may select an independent testing laboratory to inspect the material at the foundry for compliance with these specifications. The cost of foundry inspection requested by the City will be paid for by the City.

PART 2 - PRODUCTS

2.01 PVC PIPE

- A. Shall be made of polyvinyl chloride, Schedule 80 white pipe, conforming to ASTM D1785, Schedule 80 pipe shall have solvent welded joints only.
- B. All piping shall bear the NSF/ANSI International Standard 61 certification mark for potable water use.

2.02 FITTINGS

- A. Fittings for Schedule 80 pipe shall be socket type, solvent welded in conformance with ASTM D2467 or threaded type in conformance with ASTM D2464. Solvent welded joints shall be watertight.

2.03 SOLVENT CEMENT

- A. PVC solvent cement shall be NSF/ANSI international Standard 61 approved and be in compliance with ASTM D2564.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install where shown on the Contract Drawings and in compliance with manufacturer's instructions.

3.02 JOINTING

- A. Joints for Schedule 80 PVC pipe and fittings shall be solvent welded. All joints shall be made watertight. All pipe cutting and jointing procedures for solvent welded PVC pipe joints shall be in strict accordance with the pipe and fitting manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only.

3.03 TESTING AND DISINFECTION

- A. All PVC potable water lines shall be hydrostatically pressure tested, flushed and disinfected.

3.04 DISINFECTION OF POTABLE WATER PIPELINES

- A. General: The Contractor shall perform hydrostatic pressure and leakage tests on all pressure piping in accordance with Section 15000 – Mechanical – General Requirements.

END OF SECTION

SECTION 33 06 61

STAINLESS STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all labor, materials, equipment and incidentals required to supply, store, install, clean and test all stainless steel pipe and fittings where shown on the Contract Drawings and as specified herein.

1.02 QUALITY ASSURANCE

- A. All stainless steel pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The stainless steel pipe, fittings and appurtenances shall be fabricated and installed in accordance with the best practices and methods and shall comply with Contract Documents.
- B. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience and are certified in the methods and materials to be used. All field welding shall be per pipe manufacturer's written instructions.
- C. All piping and fittings of same type and duty shall be furnished by a single manufacturer.

1.03 SUBMITTALS

- A. Materials and Shop Drawings: Contractor shall submit shop drawings all materials required to establish compliance with this specification and in accordance with Section 01 33 23 Submittals. Submittals shall include at least the following:
 - 1. Certified dimensional drawings of all valves, fittings, and appurtenances.
 - 2. Joint and pipe/fitting wall construction details which indicate the type of thickness of pipe, manufacturing tolerances, and all other pertinent information required for the manufacture of the product.
 - 3. Fittings and special details such as elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials where shown on the Contract Drawings which indicate amount and position of all reinforcement. All fittings and specials shall be properly reinforced to withstand the internal pressure, both circumferential and longitudinal.

4. Process piping layout and marking diagrams which indicate the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line.
 5. Full and complete information regarding location, type, size, and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them. Joints or groups of joints in which welding sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.
 6. Upon request, complete piping design calculations shall be submitted to the Engineer. The calculations shall be in conformance with ASME standards and requirements specified herein.
 7. Shop fabrication spool drawings shall show alloys, diameters, pipe wall thickness, branches, and other joint preparation details and dimensions.
- B. Additional Information: Submit materials list showing material of pipe and fittings with ASTM reference and grade.

1.04 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 recommendations.

1.05 WARRANTY AND GUARANTEES

- A. The manufacturer shall warrant the material and products manufactured by the manufacturer shall be free from defects in materials and workmanship for a minimum period of 1 year from the date of shipment.

PART 2 - PRODUCTS

2.01 STAINLESS STEEL PIPE AND FITTINGS

- A. Manufacture: Stainless steel pipe and fittings shall be supplied by Felker Brothers Corporation, Douglas Brothers, or an approved equivalent by the Engineer.
- B. Pipe 8" and smaller shall be Schedule 40 and larger than 8" shall be Schedule 10.
- C. Pipes shall be manufactured from ASTM-A240 annealed and pickled sheets and plates and shall conform to ASTM-A312 in Grade TP 316L stainless steel. Pipe

shall be manufactured to nominal pipe sizes as listed in ANSI B36.19, Table 2. All stainless steel pipes shall have a maximum temperature of 300 degrees.

- D. Fittings shall be butt weld type manufactured in accordance with ASTM A-403 of the same grade (alloy) and in the same thickness as the pipe. Long radius elbows (i.e. centerline to end of elbow equals 1.5 times the nominal pipe size) up to 24-inch diameter shall be smooth flow type. Reducers may be straight tapered, cone type. Tees, crosses, laterals and wyes may be shop fabricated from the specified pipe.
- E. The finish on the raw material, manufactured to ASTM-A240 will be No. 1, HRAP (hot rolled annealed and pickled) or better. The finish on the completed pipe and fittings shall be as specified in ASTM-A312 and A-403, respectively.
- F. Pipes shall be straight within a maximum 1/8-inch tolerance within 10-linear feet
- G. All pieces shall be marked with gauge and type of stainless steel.
- H. All stainless steel piping, fittings, and appurtenances shall be NSF/ANSI 61 certified for potable water use.
- I. All stainless steel piping shall be Schedule 10 for potable water service.

2.02 PIPE JOINTS AND FITTINGS

- A. Flanges:
 - 1. Flanges shall be provided as a minimum at all flanged valves, meters, and other equipment. Joints and fittings unless shown otherwise in the Contract Drawings shall be welded.
 - 2. Flanged pipe ends shall be made up of grade TP 316L stainless steel Class 150-lb flange welded to pipe in accordance with ASME/ANSI B16.5 and ASTM A182. The flange shall be continuously welded to the pipe.
- B. Grooved Joint Pipe Fittings:
 - 1. Provided as indicated on the Contract Drawings.
 - 2. Grooved joint pipe fitting housing shall be Type 316 stainless steel conforming to ASTM A351, A743, and A744. The bolts and nuts shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M, Class 2 and ASTM A194, Grade B8M, Class 2, respectively.
 - 3. Manufacture: Victaulic or Gruvlock.

4. Gaskets shall be certified for NSF/ANSI 61 for potable water service.

A. Welded:

1. Pipe joints, fittings, and spools shall be shop welded by the fabricator to the fullest extent possible in 40'-0" maximum lengths with 7'-6" maximum widths for efficient commercial transport to the project site. Spools with fittings may exceed 40'-0" so long as length allows commercial transport. Smaller pipe spools shall be provided with joints as shown on the Contract Drawings for special handling, installation, and/or disassembly requirements.
2. All other joints and fitting that cannot be shop welded by the fabricator because of shipping, handling and installation of the piping shall be field welded by certified welders that have had adequate experience and are certified in the methods and materials to be used

2.03 BOLTING

A. The contractor shall supply and install flange bolting as follows:

1. Bolts and nuts for flanges shall be Type 316 stainless steel conforming to ASTM-A913, Grade B8M, for bolts and ASTM-A194, Grade 8M, for nuts.
2. Provide washer for each nut. Washers shall be of the same material as the nuts.

2.04 QUALITY ASSURANCE

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.
- B. Piping subcontractor shall submit a list of welders who will work on this project along with a welder's current certification (less than 1 year old) and two (2) sample weld coupons. Only approved welders will be allowed to work on this project.
- C. The weld should be made as rapidly as possible, with the least amount of generated heat.
- D. At random, Contractor shall visually examine via x-ray approximately 10 percent (10%) of all welds.

- E. All shop welds shall be visually inspected by the fabricator's quality control division. Each weld shall be marked with an inspection stamp, certifying that the weld is acceptable.

PART 3 - EXECUTION

3.01 FABRICATION AND INSTALLATION

- A. After the manufacture of individual stainless steel fittings and pipe lengths, they shall be pickled by immersion in a tank containing an ambient nitric hydrofluoric acid solution made up from Oakite Deoxidizer SS, or equal, and monitored to generally maintain a 25 percent (25%) or higher solution by volume of water. The duration of immersion shall be 15 to 20 minutes and may be supplemented by manually scrubbing or brushing with non metallic pads or stainless steel wire brushes. The acid treatment shall be followed by immersion in a rinse water tank, followed if necessary by a spray rinse. The stainless steel products shall then be allowed to air dry to achieve passivation.
- B. Welding of pipe joints, fittings, and spools shall be performed using welders and procedures qualified in accordance with ASME Section IX. Piping with wall thicknesses up to and including 11 gauge (0.125") shall be welded with the TIG (GTAW) process. Heavier walls shall be beveled according to procedure, root pass welded with the TIG (GTAW), and have subsequent weld passes performed using the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler metal of equal or superior ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed; weld reinforcement shall be as follows.

<u>Wall Thickness</u>	<u>Weld Reinforcement (Max)</u>	
	<u>I.D.</u>	<u>O.D.</u>
Up to 12 Ga. (0.109")	1/16"	3/32"
11 Ga. (0.125") to 3/16" Pl.	3/32"	1/8"
1/4" Plate & Larger	1/8"	3/16"

Concavity, undercut, cracks or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert argon gas shielding shall be provided to the interior and exterior of the joint. Angle face rings shall be continuously welded on both sides to pipe or fitting. Exterior welds, such as the back side of face rings or flanges and structural attachments, may be welded by the MIG (GMAW) or Metallic Arc (SMAW) process; however care must be taken to avoid melting through to the interior surface on very light walls. Excessive weld deposits, slag, spatter and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.

- C. Spools shall be fabricated to the "Pipe Fabrication Institute" fabricating tolerances ES-3 (1981).

- D. After shop fabrication into pipe spools, exterior welds shall be manually scrubbed or brushed with non metallic pads or stainless steel wire brushes to remove weld discoloration, rinsed with clean water and allowed to air dry.
- E. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart.
- F. The piping supplier during manufacturing, fabrication and handling stages, and the contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. Pipe storage and fabrication racks shall be non ferrous or stainless steel or rubber lined. Nylon slings or straps or alloy chains or cable shall be used for handling stainless steel piping. After installation, the contractor shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the contractor shall pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes and rinse clean.
- G. Painting of the stainless steel pipe is not required. However, the contractor shall be responsible for supplying and installing the stainless steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and rinsed clean.
- H. After installation, the piping system shall be tested by the Contractor according to Section 15044.

3.02 DISINFECTION OF POTABLE WATER PIPELINES

- A. General: The Contractor shall perform hydrostatic pressure and leakage tests on all pressure piping in accordance with Section 15044 – Pressure Testing of Piping.

END OF SECTION

SECTION 33 12 10

PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: This section includes materials and installation of the miscellaneous piping specialties.
- B. General Design: Specialties shall have a working pressure rating equal to or greater than the piping installed in.

1.02 QUALITY ASSURANCE

- A. Qualifications:
 - 1. All equipment furnished under this Specification shall be new and unused and shall be a standard product which has a successful record of reliable service in similar installations for a minimum of 5 years.
- B. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Mechanical Engineers (ASME)
 - a. ANSI/ASME B16.1 and B16.5 – Pipe Flanges and Flanged Fittings Package
 - 3. American Society for Testing and Materials (ASTM)
 - a. ASTM A536 – Standard Specification for Ductile Iron Castings
 - b. ASTM B62 – Standard Specification for Composition Bronze or Ounce Metal Castings
 - 4. American Iron and Steel Institute (AISI)
 - 5. Steel Structures Painting Council (SSPC), Society of Protective Coatings
 - 6. American Water Works Association (AWWA)

- a. AWWA C502 – Dry-Barrel Fire Hydrants
 - b. AWWA/ANSI C111/A21.11 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - c. AWWA C800 – Underground Service Line Valves and Fittings
 - d. AWWA C901 – Polyethylene (PE) Pressure Pipe and Tubing, ½ in Through 3 in., for Water Service
- 7. Military Specification
 - a. MIL-C-27487 – Coupling Halves, Quick-Disconnect, Cam-Locking Type
- 8. Where reference is made to standards of one (1) of the above, or other originations, the latest edition or version shall apply.
- C. Warranty: Provide manufacturer's warranty in accordance with the Division 01 - General Requirements.

1.03 SUBMITTALS

- A. Materials and Shop Drawings: Copies of all materials required to establish compliance with the Specification shall be submitted in accordance with Division 01 – General Requirements and Section 01340 – Shop Drawings, Work Drawings, and Samples. Submittals shall include at least the following:
 - 1. Certified shop drawings showing all important details of construction, dimensions (including laying length), and weight.
 - 2. Descriptive literature, bulletins, and/or catalogs showing all parts, and describing material of construction by material and specification, e.g., AISI.A.
- B. Operation and Maintenance Manuals: For all equipment furnished under this Section, the Contractor shall submit operation and maintenance manuals in accordance with Division 01 – General Requirements, to include the following:
 - 1. Equipment function.
 - 2. Description.
 - 3. Normal and limiting operating characteristics.
 - 4. Installation instructions (assembly, alignment and adjustment procedures).

5. Operation instructions (normal start-up and shut-down procedures, normal operating conditions and emergency situations).
6. Lubrication and maintenance instructions.
7. Troubleshooting guide.
8. Parts list and predicted life of parts subject to wear.
9. Drawings - cross-sectional view, assembly diagrams.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials and Equipment

1. 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.
2. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
3. Finished surfaces of all exposed openings shall be protected by wooden blanks, strongly built and securely bolted thereto.
4. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
5. 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.
6. Each box or package shall be properly marked to show its net weight in addition to its contents.

B. Storage of Materials and Equipment

1. Store equipment and accessories in an area on the construction site protected from weather, moisture, or possible damage.
2. Do not store equipment or accessories directly on the ground or in the open.

C. Handling of Materials and Equipment

1. Handle equipment and accessories to prevent damage of any nature.

2. Carefully inspect all materials for:
 - a. Defects in workmanship and materials.
 - b. Removal of debris and foreign material in equipment openings and seats.
 - c. Proper functioning of all operating mechanisms.
 - d. Tightness of all nuts and bolts.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Special Tools

1. All special tools required for normal operation and maintenance shall be provided in accordance with Division 01.

PART 2 - PRODUCTS

2.01 FIRE HYDRANT ASSEMBLIES

- A. General: Fire hydrants shall be dry barrel compression type with break-away upper section and shall conform to AWWA C502, latest edition. Hydrants shall have a minimum pressure rating of 150-psi and shall be tested at 300-psi. The main valve opening for the hydrant shall be 5¼-inches. Hydrants shall open by turning left (counter-clockwise).
- B. Outlet Nozzles:
 1. Two (2) 2½-inch hose nozzles.
 2. One (1) 4½-inch pumper nozzle.
 3. Threads shall conform to the dimensions of National Standard fire hose coupling screw threads.
- C. Inlet connection shall be 6-inch mechanical joint type.
- D. Barrel length shall be sufficient for pipe burial as shown on Contract Drawings.
- E. Spare Parts and Tools: Provide the following spare parts and tools for each hydrant:

1. One (1) Bonnet Repair Kit.
 2. One (1) Safety Flange Repair Kit.
 3. One (1) Shoe Repair Kit.
 4. One (1) Seat Wrench.
 5. Two (2) Operating Wrenches.
 6. Four (4) 10.5 Ounce Cans Hydrant Lubricant.
- F. Hydrants shall be Kennedy or Mueller A-423.

2.02 TAPPING SLEEVES AND VALVES

- A. Mechanical joint tapping sleeves shall be cast of gray-iron or ductile-iron and have an outlet flange with the dimensions of the Class 125 flanges shown in ANSI/ASME B16.1, properly recessed for tapping valve. Glands shall be gray-iron or ductile iron. Gaskets shall be vulcanized natural or synthetic rubber. Bolts and nuts shall comply with AWWA/ANSI C111/A21.11. Sleeves shall be capable of withstanding a 200-psi working pressure. Mechanical joint tapping sleeves shall be U.S. Pipe Model T-9, Mueller Model H-615, Tyler Model S-149, Waterous Model A-212, M&H Model F-5205, Clow Model 1174, or American Darling Model AD.
- B. Tapping valves shall be resilient seat gate valves, however, the end configuration shall be compatible with the tapping sleeve.

2.03 SERVICE SADDLES, CORPORATION STOPS, CURB STOPS, AND SERVICE LINES

- A. Service saddles shall have ductile iron bodies in accordance with ASTM A536, latest revision, with double stainless steel straps. Ductile iron body shall have a fusion bonded nylon coating with a minimum thickness of 12-mils. Straps shall be AISI Type 316 stainless steel with premium grade AISI Type 316 L stainless steel bolts and AISI Type 316 stainless steel washers and nuts. The nuts shall be Teflon coated. The gasket material shall be an elastomeric compound resistant to degradation by oil, natural gas, acids, alkalies, most aliphatic fluids, and chloramines. Service saddles shall be rated for a working pressure of at least 200-psi. The outlet of the saddle shall have AWWA tapered threads for corporation stops or IP threads for gate valves. Service saddles shall be manufactured by Rockwell, Ford, Smith-Blair or an approved equal by the Engineer.
- B. Corporation stops shall be designed and manufactured in accordance with AWWA C800, latest edition. Inlet threads shall be AWWA-taper thread (CC). Outlet shall be fitted with connections to suit connecting pipe or tube. Provide insert stiffeners for plastic tubing and Polyethylene (PE) pipe. Corporation stops shall be

manufactured by Mueller, Ford Meter Box Company, or an approved equal by the Engineer.

- C. Curb stops shall be constructed of bronze conforming to AWWA C800 (ASTM B62). Seats and O-rings shall be of Buna-N rubber. Inlet and outlet connections shall be compatible with adjacent pipe, tubing, yokes, or meters as applicable. Insert stiffeners shall be provided for plastic tubing and polyethylene pipe. Curb stops shall be Mueller Oriscal III or Ford Ball Valve Curb Stops.
- D. Potable water service lines shall be polyethylene tubing conforming to AWWA C800 and AWWA C901. Tubing shall be rated for a working pressure of 200-psi.

2.04 SAFETY SHOWER AND EYE WASH

- A. Emergency shower and eye wash stations shall be Haws Model 8330, all stainless steel free-standing shower and eye/face wash, or approved equal by Engineer. Furnish complete with deluge shower head, 1¼-inch full flow ball valve actuated by pull rod and ring, hand and foot operated stainless steel, aerated eye/face wash stanchion, floor flange, and interconnecting fittings. Provide a 1½-inch supply inlet, and 1¼-inch waste tee.
- B. Each shower and eye wash station shall be furnished with an emergency alarm system to indicate use of the unit. Flow switches shall be suitable for outdoor service and for operation on a 120 volt, 60 Hertz power supply. The alarm system shall be Haws Model 9001 with Option SP154DPDT or an approved equal by Engineer.

2.05 WALL SLEEVES, SEALS, AND PIPES AND NON-STANDARD CASTINGS

- A. Wall Sleeves:
 - 1. Wall sleeves shall be of cast iron, ductile iron, or hot-dip galvanized carbon steel and shall have a waterstop ring located in the center of the wall. Sleeves shall be provided with seals and shall be oversized as required for the installation of seals. Sleeves shall terminate flush with finished surfaces of walls and ceilings, and shall extend 2-inches above the finished floor.
 - 2. When noted on the Contract Drawings, smaller pipe sleeves in CMU specified as PVC, shall be Schedule 80 PVC. Sleeves shall be grouted in place and shall be oversized as required for the installation of the process pipe and sealant materials. Sleeves shall terminate flush with finished surfaces of walls and ceilings, and shall extend 2-inches above the finished floor.
 - 3. For poured or grouted in place sleeves, lightweight, high-impact thermoplastic sleeves may be substituted. Plastic sleeves shall have an

integral waterstop and anchoring ribs. Plastic sleeves shall be a product of the sleeve seal manufacturer and shall be Century Line Sleeves as manufactured by Thunderline Corporation or an approved equal by the Engineer.

4. Wall sleeves shall be installed for all piping passing through building walls and floors, except where noted on the Contract Drawings. Sleeves shall be of sufficient size to pass the pipe without binding. Sleeves shall terminate flush with finished surfaces of walls and ceilings, and shall extend 2-inches above the finished floor. Escutcheons shall be provided at walls and floor to completely conceal the sleeves smaller than 3-inches. Escutcheons shall be cast iron, nickel plated split-type.

- B. Wall Sleeve Seals: Wall sleeve seals shall be modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall sleeve. The synthetic rubber shall be suitable for exposure to water, wastewater, and groundwater. Bolts, nuts, and hardware shall be AISI Type 316 stainless steel. The seals shall be Link Seal as manufactured by Thunderline Corporation or an approved equal by the Engineer.

2.06 QUICK DISCONNECT COUPLINGS AND DUST CAPS

- A. Quick couplings and dust caps shall be installed as shown on the Contract Drawings or specified. Quick couplings shall be manufactured to the dimensional specifications of MIL-C-27487 to be compatible with couplings of other manufacturers and delivery hose systems. Quick couplings shall be AISI Type 304 stainless steel and the dust cap shall be aluminum. A 1/16-inch vent opening shall be frilled in each dust cap to prevent pressurization of the cap.
- B. The quick couplings and dust caps shall be the Autolock Coupling Series or Kamlok Series manufactured by OPW Engineered Systems or an approved equal by the Engineer.

2.07 HOSE BIBBS

- A. Hose bibbs shall be installed as indicated on the Contract Drawings or specified.
- B. For potable water system: Hose bibbs shall be ¾-inch brass or rough chrome plated with vacuum breaker and loose key stop. Hose bibbs shall have a screwed inlet and outlet to connect to a screwed water supply hose. Hose bibbs shall have a minimum 100-psi nonshock, cold water pressure rating. Hose bibbs shall be Chicago, Sloan, or an approved equal by the Engineer.

- C. For reuse water system: Hose bibbs shall be $\frac{3}{4}$ -inch bronze body angle or ball valves with a screwed inlet and outlet to connect to a screwed water supply hose. Hose bibbs shall have a minimum 100-psi nons shock, cold water pressure rating. Bibbs shall be by Crain, Walworth, or an approved equal by the Engineer.
- D. Tags: Provide permanent, plastic or brass name tags located above hose bibbs that state either "POTABLE" or "REUSE WATER – DO NOT DRINK" as required. Letter shall be approximately $\frac{3}{4}$ -inch in height.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install piping specialties of the sizes and types in accordance with the manufacturer's instructions, and in the locations shown on the Contract Drawings or specified herein.

END OF SECTION

SECTION 33 12 60

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish and install all pipe supports as indicated and as specified herein.
- B. Number and Location: The Contract Drawings depict only minimum pipe support locations. Adequate pipe supports shall be supplied for all piping systems to provide a rigid overall installation and additional support for pipe ends when equipment is disconnected.

1.02 SUBMITTALS

- A. Submit to the Engineer in accordance with Section 01340 - Shop Drawings, Work Drawings, and Samples.
- B. Submit manufacturer's descriptive literature for all pipe support devices and materials demonstrating compliance with this section and the support details shown on the Contract Drawings.

1.03 QUALITY ASSURANCE

- A. Qualifications:
 - 1. All equipment furnished under this Specification shall be new and unused and shall be a standard product which has a successful record of reliable service in similar installations for a minimum of 5 years.
- B. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Mechanical Engineers (ASME)
 - a. ANSI/ASME B16.1 and B16.5 – Pipe Flanges and Flanged Fittings Package
 - 3. American Society for Testing and Materials (ASTM)

- a. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - b. ASTM A320 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
 - c. ASTM D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- 4. American Iron and Steel Institute (AISI)
- 5. American Water Works Association (AWWA)
 - a. AWWA/ANSI C150/A21.50 – Thickness Design of Ductile-Iron Pipe
 - b. AWWA/ANSI C151/A21.51 – Ductile Iron Pipe, Centrifugally Cast
- 6. Where reference is made to standards of one (1) of the above, or other originations, the latest edition or version shall apply.
- C. Warranty: Provide manufacturer's warranty in accordance with the Division 01 - General Requirements.

PART 2 - PRODUCTS

2.01 PIPING SUPPORTS FOR METAL PIPE

- A. Furnish and install supports necessary to hold the piping and appurtenances in a firm, substantial manner at the lines and grades indicated on the Contract Drawings or specified. Piping supports and hangers shall conform to Federal Specification WW-H-171 or shall be as specifically shown or indicated on the Contract Drawings. Piping within structures shall be adequately supported from floors, walls, ceilings or beams. Supports from the floor shall be approved flange supports, saddle stands or suitable concrete piers as indicated or approved. Pipe saddles shall be shaped to fit the pipe with which they will be used and shall be capable of screw adjustment.
- B. Concrete piers shall conform accurately to the bottom $\frac{1}{3}$ to $\frac{1}{2}$ of the pipe. Piping along walls shall be supported by approved wall brackets with attached pipe rolls or saddles or by wall brackets with adjustable hanger rods. For piping supported from the ceiling, approved rod hangers proportioned for the size of pipe to be supported and of a type capable of screw adjustment after erection of the pipeline, with suitable adjustable concrete inserts or beam clamps, shall be used. The use of perforated band iron strap (plumber's strap), wire, or chain as pipe hangers will not be acceptable. If required, piping supports shall be placed so as to provide a uniform slope in the pipe without sagging. Supports shall be located wherever necessary in the opinion of the Engineer; however, in no case shall they exceed the dimensions

shown herein. Adequate supports shall especially be used adjacent to valves and fittings in pipelines. Fabricated steel or cast iron pipe supports, saddles, rolls, brackets and the like shall be as manufactured by Grinnell or an approved equal by the Engineer.

- C. All fabricated steel or cast iron pipe supports, saddles, rolls, brackets, devices, and the like shall be hot dip galvanized after fabrication and/or machining in accordance with ASTM A123. All nuts, bolts, clips and other hardware, and all hanger rods used for pipe supports, shall be AISI Type 316 stainless steel. All nuts, bolts and threaded rods shall be in accordance with ASTM A320, Class 2. All such devices shall be painted in accordance with Section 09900 – Painting and Coating, after installation.

2.02 PIPE SUPPORTS FOR PLASTIC PIPE

- A. Single plastic pipes shall be supported by pipe supports as previously specified herein.
- B. Multiple, suspended, horizontal plastic pipe runs, where possible, and rubber hose shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burntly, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of mild steel construction. Rung spacing shall be approximately 18 inches for plastic pipe and 12 inches for rubber hose. Tray width shall be approximately 6-inch for single runs of rubber hose and 12 inches for double runs of rubber hose. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc. required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners equal to Globe Model M-CAC, Husky-Burndy Model SCR or approved equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe.
- C. Individual clamps, hangers, and supports in contact with plastic pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

2.03 PIPE SUPPORTS FOR SMALL DIAMETER PVC PIPE AND STEEL PIPE

- A. Small diameter PVC piping 4-inches in diameter and smaller, shall be supported with AISI Type 316 stainless steel pipe supports. Hardware used for pipe supports shall be AISI Type 316 stainless steel.
- B. In some cases, to adequately support small diameter PVC or steel piping, a metal frame support structure may be required for support of the piping system. Where required, metal frame support structures shall be constructed using channels, fittings, brackets, hardware and other accessories as manufactured by B-Line Systems, Inc. or an approved equal by the Engineer. The materials for the frame

structure shall be Type 316 stainless steel unless otherwise noted on the Contract Drawings. Hardware used to construct the frame support structure shall be Type 316 stainless steel.

- C. Pipe supports for small diameter PVC and steel piping shall be located wherever necessary in the opinion of the Engineer to adequately support the pipe; however, they shall have a maximum spacing as specified hereinafter for straight pipe runs. Adequate supports shall especially be used adjacent to valves and fittings in pipelines.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install hangers or supports at all changes in direction at the spacing requirements stated in this specification and at the end of piping runs to minimize the stresses imposed on piping, valves, associated equipment and appurtenances.
2. Piping support systems and accessories shall be installed in accordance with the manufacturer's installation instructions.
3. Install all hangers, supports, rods, inserts, clamps, bolts and other supporting devices of sizes and spacings to prevent loads from exceeding the manufacturer's maximum recommended loading with a safety factor of 5.0.
4. Secure hangers to beams or approved concrete insert where possible.
5. When piping is installed on structural steel supports, provide blocking of pipe rolls to prevent lateral pipe movement.
6. Do not support piping from other pipes or from stairs and walkways.
7. Where possible, set all inserts or anchor bolts before concrete is placed.

B. Expansion and Contraction:

1. Rigidly support all piping with adequate provisions for expansion and contraction.
2. Firmly anchor horizontal runs over 50-feet in length at the midpoint of the runs to force expansion equally toward the ends.

C. Spacing:

1. Install hangers and supports at sufficiently close intervals to maintain alignment and prevent sagging.
2. The following table is based on spacing requirements for hard drawn copper tube, Class 53 DIP, Schedule 80 PVC, or Standard Weight (Schedule 40) steel pipe carrying a fluid with a Specific Gravity of 1.0 at a temperature not exceeding 120°F. Support spacing for other pipe materials or for piping carrying fluids with a Specific Gravity or temperature exceeding those stated above shall be approved by the Engineer. Maximum spacing of hangers and supports shall be as follows:

Nominal Pipe Diameter, (inches)	Support Spacing, Feet			
	Copper	Ductile Iron	Plastic	Steel
½	4.0	N/A	3.5	4.5
¾	4.0	N/A	4.0	5.0
1	4.0	N/A	4.5	5.5
1¼	6.0	N/A	5.0	6.5
1½	6.0	N/A	5.0	7.5
2	6.0	N/A	5.5	8.0
2½	6.0	N/A	5.5	8.0
3	6.0	N/A	6.0	8.0
4	N/A	8.0	7.0	8.0
Larger than 4	N/A	See Note	N/A	See Note

Note: Spacing shall be 10 feet maximum but may be increased depending on pipe size. Refer to AWWA standard of practice.

D. Supporting Vertical Piping:

1. Support at a maximum of 10-feet spacing.
2. Support at all points necessary to insure rigid installation with adequate provisions to allow expansion and contraction and prevent vibration.
3. Support by approved pipe collars, clamps, brackets, or wall rests.

E. Supporting PVC:

1. Support in strict accordance with the manufacturer's instructions and recommendations for the conditions of operation, temperature, and size of pipe.
 2. Support in a manner which will prevent subsequent visible sagging of the pipe between supports due to plastic deformation.
- F. Drain, Waste, and Vent Piping: Support by adjustable hangers.
- G. Valves, Fittings, and Specialties: Independently support pipe, valves, and specialties connected to pumps and equipment.
- H. Temporary Pipe Supports:
1. Lay out each section of pipeline and make connections while the pipe is held in temporary supports.
 2. After the completion of connections in each section of pipeline, hold the section in place with temporary clamps.
 3. Do not remove the temporary clamps until the piping is correctly installed on the permanent supports.
- 3.02 PAINTING
- A. All fabricated steel or cast iron pipe supports, saddles, brackets, rolls, clevises and the like shall be painted, after installation, as specified in Sections 09900 – Painting and Coating and Section 09905 – Piping, Valve, and Equipment Identification Systems.

END OF SECTION

SECTION 33 13 16

POTABLE WATER TANK TESTING AND DISINFECTION

PART 1 – GENERAL

1.01 Summary

- A. The Contractor shall perform all cleaning, flushing, testing, and disinfection for water storage tanks for NAU, including conveyance of test water from NAU-designated source to point of use, and including all disposal thereof, complete and acceptable, all in accordance with the requirements of the Contract Documents.
- B. Hydraulic testing is intended to verify that the Contractor's work on the existing storage tanks have not impacted the water tightness of the tanks.

1.02 WATERTIGHTNESS OF STRUCTURES

- A. It is the intent of these Specifications that all concrete and metal repair work, sealing work around built-in items and penetrations be performed as required to ensure that groundwater, surface water, and water or liquids in tanks, channels and containers will not intrude into any equipment rooms, pipe trenches, habitable areas or other generally dry areas.
- B. The required watertightness shall be achieved by quality concrete construction and proper sealing of all joints and penetrations.

1.03 DISINFECTION

The disinfection procedure shall result in a tank totally free from coliform bacteria.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Water for testing the reservoir shall be furnished by NAU. The Contractor shall make all necessary provisions for conveying the water from the source to the points of use.

2.02 TIGHTNESS CRITERIA

- A. The criteria for this test shall be the HST-VIO as defined by ACI 350.1-01. The criteria only requires a Visual Inspection Only for leaks. No independent laboratory is required for this test.
- B. Contractor shall comply with the test procedures outlined in ACI 350.1-01.

- C. The elevation of the water for testing shall be the elevation of the overflow pipes in the tank.

PART 3 – EXECUTION

3.01 GENERAL

- A. The test shall be performed after all interior repairs, cementitious waterproofing and coatings have been applied.
- B. The Contractor shall be responsible to repair any visible leaks by the methods described under Section 03 93 00.
- C. Release and disposal of water from structures, after testing has been completed, shall be as acceptable to NAU.

3.02 DISINFECTION OF STRUCTURES

- A. Prior to disinfection, structures shall be cleaned thoroughly by scrubbing with an approved cleaning agent and then hosing down all surfaces with a high pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. All water, dirt and foreign material accumulated during this cleaning operation shall be discharged from the structure or otherwise removed.
- B. Protective coatings and other finishes shall be applied to structures prior to performance of disinfection procedures.
- C. All structures which store or convey potable water shall be disinfected by chlorination. Chlorination of structures shall be performed in accordance with the requirements of ANSI/AWWA C652 using a combination of chlorination Methods 2 and 3 as modified herein.
- D. Chlorination (Hypochlorite): A strong chlorine solution of approximately 200 mg/L shall be sprayed on all interior surfaces of the structure. Following this, the structure shall be partially filled with water to a depth of approximately one foot. During the partial filling operation, a chlorine water mixture shall be injected by means of a solution-feed chlorinating device in such a way as to give a uniform chlorine concentration during the entire filling operation. The point of application shall be such that the chlorine solution will mix readily with the inflowing water. The dosage applied to the water shall be sufficient to provide a chlorine residual of at least 50 mg/L upon completion of the partial filling operation. Precautions shall be taken to prevent the strong chlorine solution from flowing back into the lines supplying the water. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the lines with the heavily chlorinated water. All chemicals for chlorination shall be furnished by the Contractor.

- E. Retention Period: Chlorinated water shall be retained in the partially filled structure and appurtenant piping long enough to destroy all non-spore-forming bacteria, and in any event, for at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual in the structure and appurtenant piping shall be at least 25 mg/L when tested according to Standard Methods. All valves shall be operated while the lines are filled with the heavily chlorinated water.
- F. Final Filling of Structure: After the free chlorine residual has been checked, and has been found to satisfy the above requirement, the water level in the structure shall be raised to its final elevation by addition of potable water and held for 24 hours. Before final filling is commenced, the quantity of heavily-chlorinated water remaining in the structure after filling the piping shall, unless otherwise acceptable to NAU, be sufficient, when the water level is raised to its final elevation to produce a free chlorine residual of between 1 and 2 mg/L. After the structures have been filled, the strength of the chlorinated water shall be determined. If the free chlorine residual is less than 1 mg/L, an additional dosage shall be applied to the water in the structure. After 24 hours, the free chlorine residual shall be no less than 1 mg/L or an additional dosage shall be applied and the residual tested again after 24 hours. If the free chlorine residual is greater than 2 mg/L, the structure shall be partially emptied and additional potable water added. In no case shall water be released prior to the expiration of the required retention period.

3.03 BACTERIOLOGICAL SAMPLING AND TESTING

- A. As required by ANSI/AWWA C652 and as modified herein.
- B. Disinfected water treatment facilities shall be sampled and tested in accordance with ANSI/AWWA C653.

3.04 CONNECTIONS TO EXISTING SYSTEM

- A. Where connections are to be made to an existing potable water system, high test hypochlorite (HTH) shall be added to all points of connection.

END OF SECTION

SECTION 33 33 10

VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish, install, support, and test valves, gates, hydrants, strainers, stops, and faucets, (hereinafter referred to as "valves") in the location(s) and of the size(s) and quantities as shown on the Contract Drawings and specified herein. The requirements of this specification apply to all valves specified.
- B. General Design:
 - 1. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of wastewater, reclaimed water, potable water, sludge, chemicals, air, etc., depending on the applications.
 - 2. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
 - 3. For all buried valves in which the operating nut is deeper than 4-feet from the finish ground surface, an extension rod with 2-inch operating nut and upper guide shall be installed permanently in the riser section.
 - 4. Extension stems shall be provided on all valves where the operating nut is more than 3-feet below finish grade with sufficient extension to place the operating nut between 24 and 36-inches below finish grade. Provided approved stem guides and valve boxes.
 - 5. All exposed valves shall have "open/closed" position indicators. The position indicators shall be conveniently located for easy visibility. Valves shall open counter clockwise.
 - 6. All valves installed such that actuators more than 6-feet above the floor shall have chain wheel operated geared actuators with stainless steel chains. Gear actuators shall be bevel or spur gear as recommended by the manufacturer.
 - 7. All exposed valves 6-inches and larger shall be handwheel operated.
 - 8. Valve packing shall be replaceable without removing the valve from service.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. All equipment furnished under this Specification shall be new and unused and shall be a standard product which has a successful record of reliable service in similar installations for a minimum of 5 years.
2. All valves of same type and duty shall be furnished by a single manufacturer.

B. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:

1. American Association of State Highway and Transportation Officials (AASHTO)
2. American National Standards Institute (ANSI)
3. American Iron and Steel Institute (AISI)
4. American Society of Mechanical Engineers (ASME)
 - a. ANSI/ASME B16.1 and B16.5 – Pipe Flanges and Flanged Fittings Package
5. American Society for Testing Materials (ASTM)
 - a. ASTM A48/A48M – Standard Specification for Gray Iron Castings
 - b. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - c. ASTM A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
 - d. ASTM A194 – Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - e. ASTM A240/A240M – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - f. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength

- g. ASTM A351/A351M – Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
 - h. ASTM A536 – Standard Specification for Ductile Iron Castings
 - i. ASTM B124 – Standard Specification for Copper and Copper alloy Forging Rod, Bar, and Shapes
 - j. ASTM D2133 – Standard Specification For Acetal Resin Injection Molding And Extrusion Materials
6. American Water Works Association (AWWA)
- a. AWWA C508 – Swing-Check Valves for Waterworks Services 2-inch through 24-inch NPS
 - b. AWWA C517 – Resilient Seated Cast-Iron Eccentric Plug Valves
7. Steel Structures Painting Council (SSPC), Society of Protective Coatings
8. Where reference is made to standards of one (1) of the above, or other originations, the latest edition or version shall apply.
- C. Warranty: Provide manufacturer's warranty in accordance with the Division 01 - General Requirements.

1.03 SUBMITTALS

- A. Materials and Shop Drawings: Copies of all materials required to establish compliance with the Specification shall be submitted in accordance with Section 01 33 23 – Submittals and Division 01 – General Requirements. Submittals shall include at least the following:
- 1. Certified shop drawings showing all important details of construction, dimensions (including laying length), and weight.
 - 2. Descriptive literature, bulletins, or catalogs showing all valve parts, and describing material of construction by material and specification, e.g., AISI.
 - 3. Schedule of valves, referencing each valve type, end connections and actuators to the proposed location/application on the Contract Drawings.
 - 4. Valve coatings and linings, if any.
 - 5. Valve Tag Identification Schedule in accordance with Section 09 96 50 – Piping, Valve, and Equipment Identification System.

B. Operation and Maintenance Manuals: For all valves furnished under this Section, the Contractor shall submit operation and maintenance manuals in accordance with Division 01 – General Requirements, to include the following:

1. Equipment function.
2. Description.
3. Normal and limiting operating characteristics.
4. Installation instructions (assembly, alignment and adjustment procedures).
5. Operation instructions (normal start-up and shut-down procedures, normal operating conditions and emergency situations).
6. Lubrication and maintenance instructions.
7. Troubleshooting guide.
8. Parts list and predicted life of parts subject to wear.
9. Drawings – cross-sectional view, assembly diagrams.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials and Equipment

1. 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.
2. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
3. Finished surfaces of all exposed openings shall be protected by wooden blanks, strongly built and securely bolted thereto.
4. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
5. 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.
6. Each box or package shall be properly marked to show its net weight in addition to its contents.

B. Storage of Materials and Equipment

1. Store valves and accessories in an area on the construction site protected from weather, moisture, or possible damage.
2. Do not store valves or accessories directly on the ground or in the open.

C. Handling of Materials and Equipment

1. Handle valves and accessories to prevent damage of any nature.
2. Carefully inspect all materials for:
 - a. Defects in workmanship and materials.
 - b. Removal of debris and foreign material in valve openings and seats.
 - c. Proper functioning of all operating mechanisms.
 - d. Tightness of all nuts and bolts.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Special Tools:

1. All special tools required for normal operation and maintenance shall be provided in accordance with Division 01 – General Requirements.
2. One (1) each tee handle operator shall be provided for every three (3) buried valves.

B. Spare Parts: Provide the spare parts as recommended by the manufacture which shall be packaged for potential long-term, dry storage. The manufacturer and supplier shall have published a guaranteed parts stock program in the State of Florida. These parts shall include at least one (1) set of spare parts.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Materials shall be as indicated herein, or on the Contract Drawings, and compatible with intended use.
- B. Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently stainless steel attached plate.

- C. Bolts, washers, nuts, and gaskets for flanged valves shall be as described in the specific piping sections.
- D. Coat metal valves located above ground or in vaults and structures the same as the adjacent piping. Apply the specified prime coat at the place of manufacture. Apply finish coat in field. Finish coat shall match the color of the adjacent piping. All prime and finish coats shall be in compliance with Section 09 96 00 – Painting and Coatings.
- E. Valves shall have a minimum working pressure of 150-psi or be of the same working pressure as the pipe they connect to, whichever is higher, and suitable for the pressures noted where they are installed.
- F. Identification of valves shall be in accordance with Section 09 96 50 – Piping, Valve, and Equipment Identification System.

2.02 VALVE BOXES

- A. Valve boxes shall be provided for all buried valves. Valve boxes shall be one complete assembled unit composed of the valve box, extension stem and operating nuts. All moving parts of the extension stem shall be enclosed in a housing to prevent contact with the soil. Valve box assembly shall be adjustable to accommodate variable trench depths. The extension stem shall be AISI Type 304 stainless steel.
- B. The entire assembly shall be made of minimum ¼-inch heavy wall high density polyethylene. All components shall be joined with a permanent locking design. The valve box top section shall be adaptable to fit inside a standard valve box upper section.
- C. The stem assembly shall be of a telescoping design that allows for variable adjustment length. The material shall be galvanized steel square tubing. The stem assembly shall have a built-in device that keeps the stem assembly from disengaging at its fully extended length. The extension stem must be torque tested to 1,000-foot-pounds.
- D. Valve boxes installed within paved or gravel roadways shall be designed for AASHTO H-20 truck loadings.
- E. Valve box shall be manufactured by American Flow Control's Trench Adapter, Alabama Pipe Company, or Chapman Valve Manufacturing Company.

2.03 CHECK VALVES

- A. General:

1. Valves shall be iron body, bronze-mounted, single-disc (unless otherwise specified) with materials of construction meeting the requirements of AWWA Specification C508. Valves shall be constructed to allow disc and body seat to be easily removed and replace with removing the valve from the line.
 2. Ends shall be flanged, ANSI/ASME B16.1, Class 125, latest edition. Minimum valve working pressure shall be 150-psi. Check valves shall be furnished with outside lever arm and weight or spring. Provide externally mounted proximity switch and lever to indicate closed or open check valve.
 3. The shop drawings submittal shall include a detail showing how the AISI Type 304 stainless steel hinge pin extends through the valve body. Show packing gland, hinge pin gland, cap, and other pieces utilized.
 4. All check valves of the same type shall be by one (1) manufacturer unless otherwise specified.
- B. Rubber Flapper Swing Flex/Swing Check Valves (Sewer/Sludge and Low Pressure Effluent Pumping Application; i.e., less than 50 psi).
1. Valves shall have a cast iron body and cover meeting ASTM A126, Class B specifications.
 2. Flapper shall be Buna-N reinforced and shall be easily removed without any need to remove the valve from line.
 3. Ends shall be flanged, 125 pound ANSI B16.1. The flapper shall be Buna-N having an "O" ring seating edge and be internally reinforced with steel.
 4. Valve shall provide drip-tight shutoff.
 5. Where shown on the electrical drawings, check valves shall be provided with an NEMA 4X limit switch mounted on the horizontal centerline of the body seat or through the cover mounted on a mechanical position indicator.
 6. Provide a manually operated backflow device which shall positively lock open flapper during full backflow.
 7. The flex portion of the disc shall have a 20 year warranty.
 8. Valves shall be manufactured by Apco Valve and Primer Corp., Series 100, Val-Matic Valve and Manufacturing Corp., Swing Flex, or equivalent.
- C. Swing Check Valves, 2½-inches and Smaller.

1. Screwed ends, 200-lb. WOG minimum, 158 bronze or all-brass swing-check valves. Screw-on cap and renewable composition discs.
2. Wetted bronze parts shall contain less than 16 percent (16%) zinc.
3. Minimum valve working pressure shall be 150-psi.
4. Valves shall be manufactured by Crispin, Crane Co.; Clow Valve Co.; M&H Valve Co.; or Mueller Co.

D. Pinch Check Valves:

1. Valve shall consist of a neoprene sleeve, reinforced with fabric nylon ply, slipped over the end of a pipe and securely banded.
2. The maximum working pressure shall be 8-psi, and a maximum back pressure shall be 24-psi. Valve shall open at a maximum differential pressure of 5-inches of water.
3. Draw bands shall be all AISI Type 316 stainless steel.
4. Valve shall be manufactured by Onyx or Red Valve or an approved equal by the Engineer.

E. Dual Disc Check Valve:

1. Dual disc valves shall be used on air process lines only.
2. The valve shall have a cast iron body wafer design with aluminum plates, stainless steel spring and silicon sealing material.
3. The silicon seal material shall be suitable for operating temperatures up to 400°F.
4. The valve shall be sized for full pipeline and when installed in the vertical pipeline, flow must be upward through the valve.
5. The wafer type valves shall be designed to mount between the two (2) 125 pound ANSI flat faced flanges. Note that valve plate clearance must be allowed on the discharge side.
6. Valves shall be manufactured by Sure Check by Mueller Steam Specialty, Stockham by Crane Co., or Titan Flow Control, Inc.

2.04 PLUG VALVES

- A. Manufacturers: DeZurik, Inc.; Clow Valve Co.; or M&H Valve Co. All plug valves of same type shall be by one (1) manufacturer unless otherwise specified.

- B. Eccentric Plug Valves 3 to 36-inches shall meet or exceed the latest revision of AWWA Specification C517, latest edition, and shall meet or exceed the requirements of this specification.
- C. Valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the plans. Flanges shall be per the ANSI, B16.1, Class 125 standard, latest edition. End-to-end length of flanged valves shall be per AWWA C517, Table 1. Mechanical joint ends for buried valves shall be to the AWWA Standard C111.
- D. Bodies of cast iron, ASTM A126 Class B with bolted bonnets. Suitable for 175-psi working pressure for valves 12-inch and smaller.
- E. Bodies shall be of ASTM A126 Class B cast iron. Port area shall be 100 percent (100%) of standard pipe area. Neither published nor calculated C_v flow data will be accepted in lieu of 100 percent (100%) port area requirement. The body shall have minimal pooling, and provide complete flushing of the valve every time it cycles. Port of valve shall be rectangular. Round ported valves will not be accepted. Only VE option that will be considered is rectangular seated non 100 percent (100%) port valves. VE option of round port valves will not be accepted.
- F. Provide valves with coated plugs with mating seats of 90 percent (90%), minimum, pure nickel welded into the body of valves 3-inch and larger.
- G. Seats shall be rectangular ported, $\frac{1}{8}$ -inch thick welded overlay of not less than 95 percent (95%) pure nickel. Seat area shall at least $\frac{1}{2}$ -inch wide and raised, with the raised surface completely covered with weld to insure that the plug face contacts only nickel.
- H. Grit Excluders in the form of PTFE washers at the upper and lower journals shall be provided to prevent the entry of grit and foreign solids into the bearing areas.
- I. Stem seals of either adjustable multiple V-packing or multiple point contact rubber rings. Stem seals replaceable without valve disassembly.
- J. Pressure ratings shall be 175-psi (1,207-kPa) for sizes 3-inches through 12-inches (80-300mm) and 150 psi (1,034-kPa) for sizes 14-inches through 36-inches (350-900mm). Every valve shall be given a hydrostatic and seat test, with test results being certified when required by the specifications.
- K. Two-Way Valves:
 - 1. Non-lubricated, eccentric type, cast iron body with end type as shown on the Contract Drawings.
 - 2. Packing shall be BUNA (VEE) with a maximum temperature of 350°F.

3. Bearings shall be stainless steel or bronze as required.
 4. Suitable for particular service in piping in which installed.
- L. Three-Way and Four-Way Valves:
1. Equal to that specified for two-way valves.
 2. Port location, style, and arrangement as shown on the Contract Drawings and as required.
- M. Actuators (type as shown on the Contract Drawings and specified herein):
1. Lever and Tee Handle Actuators: Size and length as required with a 2-inch square socket end for use on 2-inch square actuating nut. Attached handle to valve with a 4-foot length of chain.
 2. Handwheel Actuators:
 - a. Totally enclosed gear type.
 - b. Sized for the operating conditions encountered.
 - c. Use on all valves 6-inches in size and larger, and on smaller valves when valve location does not allow level actuator.
 3. Chain Wheel Actuators:
 - a. Totally enclosed gear type.
 - b. Chain shall extend to 3-feet above floor unless otherwise shown.
 - c. Chains and actuators shall be stainless steel.
 - d. Use for all valves that are located with centerline 6-feet or more above floor.
 4. Motor actuator for the backwash and transfer valves: 480V, 3-phase
- N. Manual valves shall have lever actuators or gear actuators with tee wrenches, extension stems, floorstands, etc. as indicated on the plans. All valves 6-inches and larger shall be equipped with gear actuators. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. All actuator shafts shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. All exposed nuts, bolts, and washers shall be a minimum of AISI Type 304

Stainless Steel. Valve packing adjustment shall be accessible without disassembly of the actuator.

- O. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washers shall be a minimum of AISI Type 304 Stainless Steel.
- P. All buried plug valves shall have a remote position indicator in the valve box showing position of the valve. A centering and identification plate shall be provided showing open and close position and number of turns to open for each valve. The position indicator shall be stainless steel or other material protected from corrosion.
- Q. Remotely actuated motorized plug valves shall be in accordance with Section 33 33 13 – Electrically Actuated Control Valves.

2.05 GATE VALVES

- A. Manufacturers: Mueller Co., Kennedy Valve Co., or US Pipe. All gate valves of same type shall be by one (1) manufacturer unless otherwise specified.
- B. General Service 2-inch and smaller, above ground:
 - 1. Bronze construction - 125 pound steam.
 - 2. Union bonnet.
 - 3. Outside screw and yoke (OS&Y), rising stem
 - 4. Solid disc, taper wedge.
 - 5. End connections:
 - a. Threaded
 - b. Or solder ends for copper pipe systems
 - 6. Cast iron hand wheels.
- C. General Service - 2 ½-inches through 30-inches:
 - 1. Ductile iron body, bonnet and bonnet cover, ASTM A536, 200-psi working pressure.

2. Outside screw and yoke (OS&Y), rising stem type for above-ground service, Non-rise stem type for under-ground service, made of cast, forged or rolled bronze.
 3. Ductile iron gate with vulcanized EPDM synthetic rubber coating (resilient seated). Zero leakage at 200 psi.
 4. Valves for buried service shall have mechanical joints conforming to ANSI A21.11, above ground service joints shall be flanged conforming to ANSI B16.1 for Class 125 flanges.
 5. All ferrous surface inside and outside shall have a resilient wedge type epoxy coating.
- D. Valves for buried service shall have 2-inch square operating nut
- E. General Service - Greater than 30-in: Valves shall meet the requirements of 2.02.B except as specified otherwise below:
1. Operator shall be bevel or spur geared.
 2. In horizontal installations, valves shall be equipped with bevel gear suitable for buried service.
 3. Valves 42-in and greater shall be provided with by-pass gate valve.
 4. Working pressure shall be a minimum of 150 psi.

2.06 BUTTERFLY VALVES

- A. Manufacturers: DeZurik, Inc. or Norriseal. All butterfly valves of same type shall be by one (1) manufacturer unless otherwise specified.
- B. Butterfly valves in sizes 2-inches through 20-inches shall have single-offset disc, and shall be of the lug body style. All valves shall be suitable for use with ANSI class 125 or 150 flanges. Valve shall provide bi-directional drip-tight shutoff at pressures to 250 psi with 316 stainless steel disc/shaft.
- C. Bodies shall be ASTM A536 ductile iron. Wafer valves shall have four flange bolt guides to center the body in the pipeline. Lugged body valves shall provide tight shutoff up to the full valve rating on dead end or isolation service without the use of downstream flanges.
- D. Discs shall be offset to provide an uninterrupted 360 degree seating edge and shall be 316 stainless steel. The disc/shaft connection shall be splined.

- E. Elastomer seats shall fully line the valve body and be permanently bonded. Seats shall be FKM. Seats shall have integral flange seals so flange gaskets are not required.
- F. Shafts shall be one-piece 416 stainless steel, or 316 stainless steel when using stainless steel disc. Shaft diameters shall meet the AWWA C504, class 75B standard. Multiple shaft seals shall be provided to prevent leakage.
- G. Three shaft bearings made of heavy-duty aluminum bronze shall be provided to ensure smooth, reliable valve operation.
- H. Lever operators shall provide automatic, positive latching in the open, closed and eight intermediate positions and shall be used for applications with air piping.
- I. Gear actuators shall be provided on valves 8" and larger. Actuators shall have cast iron weatherproof or buriable construction, and shall have adjustable open and closed position stops. Operating shaft to be supported axially and radially at the input end by permanently lubricated thrust and sleeve bearings.

2.07 PRESSURE REDUCING VALVES

- A. The pressure reducing valve will be a model 8" 90-05BPSVYKC D.S. SSB 150ansi X101 as manufactured by Cla-Val Co., Newport Beach, CA.
- B. Valve will be designed as a pressure reducing valve with return flow feature. It will be designed maintain a constant downstream pressure to the lower zone regardless of inlet pressure or flow fluctuations or downstream demand. It will open when the downstream zone pressure drops to feed water from the high side. This flow through the pressure reducing valve will be dictated by the downstream demand. It will include a normally open CRD pressure reducing pilot control that modulates varying the pressure on the main valve cover to throttle the higher inlet pressure to a steady lower downstream pressure. The valves will also provide for reverse flow in the case that the inlet pressure drops below the outlet pressure.
- C. The main valve will be supplied in a 100-01 full ported main valve. It will consist of three different parts; the body with seat installed, the cover with cover bearing and the disc and diaphragm assembly. The diaphragm assembly will be the only moving part. It will be ductile iron and have stainless steel trim internals. The main valve trim will include a solid one piece stainless seat, the contoured disc guide and the stainless stem. The main will have an NSF 61 fusion bonded epoxy coating on all internal and external ferrous metal surfaces. The cover of the main valve will have a locating lip for ease of maintenance and to maintain alignment of the stem within the disc/diaphragm assembly. The main valve cover fasteners will be stainless steel. The cover will be one piece. There shall be no pins in the cover for alignment. The main valve will be of the packless design and shall have no o-rings or packing anywhere within the main valve. The main valve will have stainless steel cover bolts and nuts.

- D. The pilot control system will consist of a normally open CRD pressure reducing pilot. The CRD will be supplied with a 20-105 psi spring adjustment range. The pilot control system will also contain a “Y” strainer to prevent any debris from entering the control loop. The main valve cover will have an X101 visual valve position indicator for monitoring the valve position at any time. There shall also be gauges mounted in inlet and outlet. There shall also be an opening speed control needle valve for smooth operation.
- E. The manufacturer shall provide a direct factory employee for startup and training for the operations and maintenance personnel.

2.08 AIR RELEASE AND VACUUM RELEASE VALVES

- A. Manufacturers: Val-Matic, Crispin, or APCO Valve & Primer Corporation. All butterfly valves of same type shall be by one (1) manufacturer unless otherwise specified.
- B. Combination air/vacuum valves shall vent large quantities of air when the pipeline is filling, release small quantities of air when the pipeline is pressurized and allow reentry of air into the pipeline when pumps stop to prevent vacuum. Air release valves shall vent small quantities of air while the pipeline is pressurized
- C. Clean Water Service (Final Effluent) (Reuse Water) (Potable Water)

All air release and vacuum release valves shall be isolated from the service line with a bronze gate valve for valves up to 3 inches, and a flanged body butterfly valve for valves greater than 3 inches (provide a spacer plate if required to clear the rotation of the butterfly disc).

1. Air Valves (ARV)

- a. 3/4-inch and smaller:
 - (1) Direct acting type or simple lever type.
 - (2) Cast iron body with stainless steel float, Buna N seat, and stainless steel linkage.
 - (3) APCO No. 55 (1/2-inch), No. 65 (3/4-inch), Val-Matic 1/2-inch or 3/4-inch No. 22.4, or Crispin.
- b. 1-inch and larger:
 - (1) Float actuated compound lever type with linkage mechanism to release air.

- (2) Float shall withstand external pressure of 1000 psig without collapsing.
- (3) Cast iron body with flanged top cover and replaceable orifice. Synthetic rubber needle or disc actuated by float and linkage mechanism.
- (4) 1/2-inch threaded outlet and bronze plug for top cover and body drain.
- (5) Stainless steel float with bronze or stainless steel linkage and Buna-N needle.
- (6) APCO No. 200A (1-inch or 2-inch), No. 207 (6-inch), Val-Matic No. 38 (1-inch or 2-inch), No. 61 (6-inch) or Crispin.

2. Air and Vacuum Valves (not intended for use on potable water service)

a. General: Float assembly and large venting orifice to exhaust large quantities of air, or admit large quantities of air.

- (1) Cast iron body with flanged top containing air release orifice.
- (2) Float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seal.
- (3) Float shall withstand and external pressure of 1000 psig without collapsing.
- (4) Designs having levers and weights attached to the float will not be permitted.
- (5) Float shall have one-piece guide rod extending out of the bottom and to engage the guide bushings in the valve body at all times.
- (6) Cast iron body and cover with stainless steel float, guide rod and bushings with Buna-N seat.

b. 3-inches and smaller:

- (1) 1/2-inch threaded outlet and bronze plug for top cover and body drain.
- (2) APCO No. Series 140, Val-Matic No. 100, or Crispin.

c. Larger than 3-inches:

- (1) 1-inch threaded drain outlet and bronze plug.
- (2) 1-inch threaded outlet with bronze plug on the side of the valve body above the minimum water level in the valve, which forces the float against the valve seat.
- (3) Steel protector hood.
- (4) APCO Series 150, Val-Matic No. 100, or Crispin.

3. Combination Air Release Valves (not intended for use on potable water service):

- a. Combination of 2.01, B, 1 and 2 above. The air and vacuum valve serves to release and admit large quantities of air when the pipeline is filled or drained. The attached air release valve serves to release small quantities of air that accumulate during pipeline operation.
- b. Connect attached air release valve to air and vacuum valve with standard weight steel piping (ANSI B36.10) and an isolation gate valve.

D. Valve End Connections:

1. Valves smaller than 4 inches shall have threaded ends. Valves 4 inches and larger shall have flanged ends.
2. Flanges for Class 150 valves shall comply with ANSI B16.1, Class 125. Flanges for Class 300 valves shall comply with ANSI B16.1, Class 250.
3. Threaded ends shall comply with ANSI B2.1.

E. Bolts and Nuts for Flanged Valves:

1. Bolts and nuts for flanged valves located indoors and in vaults and structures shall be carbon steel, ASTM A307, Grade B.
2. Bolts and nuts for flanged valves located outdoors above ground shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M or bolts, and ASTM A194, Grade 8M for nuts.

F. Gaskets: Gaskets for flanged end valves shall be as described in the detail piping specifications.

2.09 PVC BALL AND CHECK VALVES

- A. All PVC ball valves ½-inch through 4-inch in size shall be of one piece capsule type manufactured of Type 1, Grade 1 PVC. Ball valves shall be true union design with two-way blocking capability and shall have solvent welded socket or NPT threaded ends.
- B. Ball valves shall be supplied with ABS lever operating handles. All PVC ball check valves shall have Teflon seats and Viton O-ring seals, and shall be designed for a 150 psi water working pressure at 120°F.
- C. PVC ball check valves shall be of Type 1 Grade 1 PVC and shall have union ends on both sides of the valves. Ball check valves shall be rated for a working pressure of 150 psi at 120 °F.
- D. All PVC ball valves and ball check valves shall be manufactured by Asahi/America, Celanese Piping Systems, Inc., Chemtrol, or Plastiline, Inc. or an approved equal by the Engineer.

2.10 STAINLESS STEEL BALL VALVES

- A. Stainless steel ball valves shall be standard port type for the sizes indicated on the Contract Drawings. Ball valves shall be designed for a working pressure of 200-psi with positive shut off when in the closed position. Valve body and ends shall be constructed of forged AISI Type 316 or ASTM A351 Type CF8M Stainless Steel and valve ends shall be NPT threaded connections. The ball shall have a full bore port design machined from a solid metal piece with highly polished surfaces. The ball and stem shall be manufactured from AISI Type 316 stainless steel. Manually operated ball valves shall be furnished with lever operators manufactured of forged AISI Type 316 stainless steel with a molded vinyl sleeve. Stainless steel ball valves shall be NIBCO or approved equal by the Engineer.

2.11 Pressure Gauges:

- A. Each pressure gauge shall be stem mounted, 4 inch or 4 1/2 inch diameter dial, and furnished with a clear acrylic window. The case and ring shall be constructed of 304 stainless steel and the bourdon tube/socket and restrictor shall be constructed of Type 316 stainless steel. The dial face shall be white coated aluminum with jet black scale and the pointer shall be black coated aluminum or stainless steel. Each gauge shall be liquid filled with 3000 centistoke silicon fluid and have an ethylene propylene blowout disc. Gauge movement shall be polyglide with nickel silver working parts and polycarbonate mounting plates. Pressure gauges shall be equipped with a lever handle gauge clock. Diaphragm seals shall be provided between the gauge cock and pressure gauge where indicated on the Drawings and on all sludge lines and lines with non-clear matter in suspension.
- B. Pressure gauge ranges shall be as specified in other sections of these specifications and the accuracy of the gauges shall be ANSI Grade A-1% of full scale.

- C. Pressure gauges shall be equal to Ametek, U.S. Gauge Division, Series 540, equal product by Marshalltown Instruments, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install valves and accessories in strict accordance with manufacturer's instructions and recommendations, as shown on the Contract Drawings and as directed by the Engineer.
- B. Carefully erect all valves and support them in their respective positions free from distortion and strain.
- C. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.
- D. Support all valves connected to pumps and equipment, and in piping systems that cannot support valves.
- E. Repair any scratches, marks and other types of surface damages, etc., with original prime coating as supply by the factory.
- F. Apply finish coating in accordance with Section 09900 – Painting and Coating.

3.02 INSPECTION AND TESTING

- A. Check and adjust all valves and accessories for smooth operation.
- B. Test valves for leakage at the same time that the connecting pipelines are tested. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the pressure tests.
- C. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseal or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints.

END OF SECTION

SECTION 33 33 13

ELECTRICALLY ACTUATED CONTROL VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish and install electrically operated plug valves, control wiring, and all ancillary devices required to provide a fully functional control valves as shown on the Contract Drawings and/or as specified herein.

1.02 QUALITY ASSURANCE

- A. Qualifications:

1. Technologies and devices used in the actuator must have a minimum of 5 years of commercial operating experience for that specific model number, including torque and position sensing, lubrication, and electrical compartment design. Manufacturer must provide ten (10) site references of similar applications in the state of Florida, including telephone numbers and individual contact names.
2. All valves and actuators shall be provided by a single manufacturer/supplier to insure single source responsibility for the proper operation of all control valves.
3. Each actuator must be performance tested and individual test certificates shall be supplied free-of-charge. The test equipment should simulate a typical valve load and the following parameters should be recorded:
 - a. Current at maximum torque setting
 - b. Torque at maximum torque setting
 - c. Flash Test Voltage
 - d. Actuator Output Speed or Operating Time

In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

- B. Standards: See Section 33 33 10 – Valves and Appurtenances.

- C. Warranty:

1. Provide manufacturers' warranty in accordance with the Division 01 – General Requirements.
2. Each actuator shall be warranted for a minimum of 24 months of operation up to a maximum of 36 months from shipment.

1.03 SUBMITTALS

- A. Materials and Shop Drawings: Copies of all materials required to establish compliance with the Specification shall be submitted in accordance with Section 01 33 23 – Submittals and Division 01 – General Requirements. Submittals shall include at least the following:
 1. Materials Listing
 2. Equipment Weights and Dimensions
 3. Electrical Drawings
 4. Control Schematics and Logic
 5. List of Special Tools/Equipment for Operation/Maintenance
 6. Equipment Testing/Demonstration Procedures
- B. Operation and Maintenance Manual: Provide O&M Manuals in accordance with Division 01 – General Requirements.
- C. Manufacturers' Certification: Manufacturer shall provide certified letter of compliance with Article 1.02.A of this specification.

1.04 OPERATING INSTRUCTIONS

- A. Provide factory representative for a minimum of one (1) eight-hour day to instruct and train the Owner and Engineer in the operation, maintenance, troubleshoot and emergency operating procedures of the automatic valves.
- B. Instructions/training shall be provided at a time that is acceptable to the Owner. Valves shall be fully operational at the time of instructions/training. Instruction/training may be provided in conjunction with the Check-Out and Demonstration requirements under Part 3, if approved by Owner.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Product Delivery, Storage and Handling: See Section 33 33 10 – Valves and Appurtenances.

1.06 SPECIAL TOOLS AND SPARE PARTS

- A. Special Tools and Spare Parts: Provide all special tools required for valve operation, maintenance and troubleshooting in accordance with Division 01 – General Requirements.
- B. Each actuator shall be supplied with a startup kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Equipment Manufacturers: Actuators shall be manufactured by Rotork IQ/IQT, or an approved equal by the Engineer. Plug valves shall be manufactured as specified in Section 133 33 10 – Valves and Appurtenances
- B. General: Valves shall comply with Section 33 33 10 – Valves and Appurtenances.
- C. The actuators shall be suitable for use on a nominal 480V, three phase power supply and are to incorporate motor, integral reversing starter, local control facilities, terminals for remote control and indication connections, and a backlit LCD display with digital position indication and alarm icons.
- D. It shall be possible to carry out the setting of the torque, turns, and configuration of the indication contacts without the necessity to remove any electrical compartment covers.
- E. Actuators shall be 'O' ring sealed, watertight to IP68, NEMA 4, 4x and 6, and shall at the same time have an inner watertight and dustproof 'O' ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed for on site for cabling.
- F. The actuator shall include an on-board data logger to store operational data such as valve torque profiles, actuator events, and statistics that can be viewed locally on the LCD screen or downloaded via infrared port. An intrinsically safe setting tool shall be furnished by the actuator manufacturer capable of data transfer from actuator to PC and include actuator diagnostic software to download, review, analyze, and reconfigure the actuator.
- G. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator.

2.02 MATERIALS

- A. Sizing: The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute unless otherwise stated in the job specification.
- B. Actuators shall be 'O' ring sealed, watertight to IP68 (7 meters-72 hours), NEMA 4, 4x and 6, and shall at the same time have an inner watertight and dustproof 'O' ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling. Enclosure protection of NEMA 6, IP68, shall be guaranteed without the need of suitable cable glands.
 - 1. Enclosure must allow for temporary site storage without the need for electrical supply connection or removal of any components.
 - 2. All external fasteners should be of stainless steel.
 - 3. Actuators for explosion/hazardous applications shall in addition be certified flameproof Class 1, Division 1.
- C. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means, with the drive being restored to power automatically by starting the motor. The hand/auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.
- D. The handwheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated in the job specification. For safety purposes, it shall be possible to disengage the electric drive with the declutch lever. This disengagement and any subsequent reengagement shall not cause any damage to the valve or operator, even with the motor running.
- E. Motor:
 - 1. The electric motor shall be Class F insulated with a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is the longer, at an average load of at least 33 percent (33%) of maximum valve torque.

2. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gearcase. Plugs and sockets are not acceptable as a means of electrical connection for the motor.
3. For plug valves 14-inch or smaller, actuators shall incorporate a motor speed controller to allow for simple, non-intrusive, field adjustable speed control. To simplify set-up, speed control shall be adjusted over a 4:1 speed range (i.e. 30-120 seconds) by any of the following means: IR setting tool, PDA and laptop PC.
4. Protection shall be provided for the motor as follows:
 - a. The motor shall be de-energized in the event of stall when attempting to unseat a jammed valve.
 - b. Motor temperature shall be sensed by a thermostat to protect against overheating.
 - c. Single phasing protection.

F. Gearing:

1. The actuator gearing shall be totally enclosed in an oil- filled gearcase suitable for operation at any angle. All main drive gearing must be of metal construction. Where the actuator operates gate valves or large diameter ball or plug valves, the drive shall incorporate a lost-motion hammerblow feature. For rising spindle valve s, the output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type at the base of the actuator, and the design should be such as to permit the gearcase to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.
2. Standard gear oil shall be used to lubricate the gearcase. Special or exotic lubricants shall not be used, as they may be difficult to source in remote locations.
3. Plug valve actuators 14-inch and smaller shall provide direct quarter-turn output and not incorporate the use of an intermediate gearbox.

G. Drive Brushing: The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bush shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base, should be of the sealed-for-life type.

H. Torque and Turns:

1. An inexpensive setting tool shall be included for non-intrusive set-up, calibration, and interrogation of the actuator. Using the vendor-supplied setting tool, torque and turns limitation shall be adjustable as follows:
 - a. Position setting range: 2.5 to 100,000 turns, with resolution to 7.5 degrees (7.5°) of actuator output.
 - b. Torque setting: 40 percent (40%) to 100 percent (100%) rated torque.
 - c. Torque sensing must be affected directly electrically or electronically. Extrapolating torque from mechanically measured motor speed is not acceptable due to response time. Torque measurement shall be independent of variations in frequency, voltage or temperature.
 - d. "Latching" to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid-travel against high inertia loads.
2. The electric circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.

2.03 CONTROLS

- A. General: Valves shall be PLC controlled and shall comply with Division 13 – Special Construction and Division 26 - Electrical.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be in accordance with the manufacturers' instructions and recommendations in the locations shown on the Contract Drawings.
- B. Installation shall include all piping and control wiring for proper automatic operation of the valve.

3.02 INSPECTION AND TESTING

- A. The Contractor shall furnish the services of a factory representative who has a complete knowledge of the proper knowledge and maintenance of all equipment furnished. Manufacturer's field services shall be provided in two parts as follows:
- B. Equipment "Check Out:" The Contractor shall furnish the services of the manufacturer's experienced, factory-trained, authorized service representative to inspect and perform "check-out" tests to assure and certify proper installation and operation of the equipment as specified in Division 01 – General Conditions.

- C. Equipment Start-Up and Demonstration Tests: The Contractor shall furnish the services of the manufacturer's experienced, factory-trained, authorized service representative to inspect and perform "start-up" or "demonstration" tests to assure and certify proper operation of the equipment as specified in Division 01 – General Conditions and shall instruct representatives of the Owner and the engineer on the proper operation and maintenance of the equipment at a time approved by the Owner. With the permission of the Owner, these services may be combined with those provided under Paragraph 1.04. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional services shall be provided at no additional cost to the Owner.

END OF SECTION

SECTION 33 33 26

EXPANSION JOINTS AND FLEXIBLE CONNECTORS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish and install flexible connectors of the type(s) and size(s) in the location(s) shown on the Contract Drawings and as specified herein.
- B. General Design: Minimum pressure rating equal to that of the pipeline in which they are to be installed.

1.02 QUALITY ASSURANCE

- A. Qualifications: The manufacturer shall have a minimum of five (5) years experience in the manufacture of the expansion joints.
- B. Standards: Design, manufacturing and assembly of elements of the products herein specified shall be in accordance with, but not limited to, published standards of the following as applicable:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Mechanical Engineers (ASME)
 - a. ANSI/ASME B16.1 and B16.5 – Pipe Flanges and Flanged Fittings Package
 - 3. American Society for Testing and Materials (ASTM)
 - a. ASTM A36 – Standard Specification for Carbon Structural Steel
 - b. ASTM A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Service Applications
 - c. ASTM A194 – Standard Specifications for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - d. ASTM A283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

- e. ASTM A285 – Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
 - f. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
 - g. ASTM B776 – Standard Specification for Electrodeposited Coatings of Cadmium
 - h. ASTM D2000 – Standard Classification System for Rubber Products in Automotive Applications
4. American Water Works Association (AWWA)
- a. AWWA C123 – Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
 - b. AWWA/ANSI C153/A21.53 – Ductile-Iron Compact Fittings
 - c. AWWA Manual of Practice No. 9 – Steel Pipe – A Guide for Design and Installation
5. Where reference is made to standards of one (1) of the above, or other originations, the latest edition or version shall apply.

1.03 SUBMITTALS

- A. Submit to the Engineer in accordance with Section 01340 – Shop Drawings, Work Drawings, and Samples.
- B. Manufacturer's catalog data showing materials of construction by ASTM reference and dimensions. Show manufacturer's model or figure number for each type of coupling or joint to be used.
- C. Provide schedule of proposed connectors referenced to each application.
- D. Manufacturer's recommended torques.
- E. Indicate number, size, and material of construction of the rods and lugs for each thrust harness.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide flexible connectors on the inlet and outlet of all pumping equipment to isolate the equipment from external stresses and vibration and to provide a means of disassembly.
- B. Materials shall be capable of withstanding the temperature, pressure and type of material in the pipeline.
- C. Supplied with control rods to restrict elongation and compression.

2.02 FLEXIBLE RUBBER SPOOL TYPE EXPANSION JOINTS

- A. General Application (any size pipeline): For maximum compensation for expansion/contraction, vibration and movement in minimal connecting space.
 - 1. Design: Molded neoprene with filled triple arches and reinforced with galvanized $\frac{3}{8}$ -inch split steel retaining rings. Filled arch type to prevent sediment build-up for all sludge, sewage, and other lines with similar service.
 - 2. Service: Suitable for above ground outdoor service.
 - 3. Connections: Flanges drilled to Class 125 as shown in ANSI/ASME B16.1.
 - 4. Minimum Working Pressures: See Table 15129B-A for working pressure and expansion requirements and Table 15129B-B for control unit rods and gusset requirements.
 - 5. Maximum Service Temperature: 180°F, minimum.
 - 6. Maximum Lateral Movement: 1½-inch, minimum.
 - 7. Cover: Protected by a covering of Hypalon paint.
 - 8. Support: Independently supported at each connecting pipe within two pipe diameters of connecting flanges. Supports shall provide expansion or restraint as shown on the Contract Drawings and Section 15126 – Hangers and Supports and shall maintain true pipe alignment.
 - 9. Expansion joints shall be as manufactured by the Red Valve Company, Metraflex, Mercer Rubber Co., or Holtz Rubber Company.
- B. Low Pressure Air Piping Applications:
 - 1. Type: Integral flange and body with tube extending through the bore to the outer edge of the flanges.

2. Materials:
 - a. Cover – chlorobutyl
 - b. Body - fiberglass impregnated with chlorobutyl
 - c. Tube - chlorobutyl
3. Body: Reinforced with not less than four securely bonded metal reinforcing rings.
4. Size: Nominal pipe size with single arch.
5. Cover: Protected by a covering of Hypalon paint.
6. Connections: Flange Class 125 as shown in ANSI/ASME B16.1 furnished with split steel, zinc coated retaining rings and control units factory set to restrict joint travel to within design limits with a safety factor of 4:1.
7. Minimum Temperature Rating: 240°F, minimum.
8. Maximum Lateral Movement: 1½-inch, minimum.
9. Support: Independently supported at each connecting pipe within two pipe diameters of connecting flanges. Supports shall provide expansion or restraint as shown on the Drawing and in Section 15126 – Hangers and Supports and shall maintain true pipe alignment.
10. Air Service: Expansion joints shall be as manufactured by Garlock Style 204, La Favorite Rubber Co., Uniroyal, Inc., or Mercer Rubber Co.

2.03 PVC EXPANSION JOINTS (for use on PVC Low Pressure Air Piping):

- A. Provide a PVC expansion joint to prevent thermally induced stresses due to expansion and contraction over a temperature range of 120°F. Expansion joints shall be air-tight and permit free and easy movement of the plain ends of the header within the coupling barrel due to expansion and contraction.
- B. Expansion joints shall consist of a barrel section, "O" ring gaskets and threaded, screw on retainer rings. Expansion couplings shall meet the following criteria:
 1. Minimum stroke:
 - a. Single end: 4-inches
 - b. Double end: 2-inches each end

2. Average force to operate – 50-pounds

2.04 SLEEVE TYPE CONNECTORS

- A. Application: For any cast-iron, ductile or steel pipeline connection requiring expansion/contraction compensation not exceeding $\frac{3}{8}$ -inch and deflection not exceeding 1.5 degrees.
- B. Full Sleeve Type (when applicable)
 1. Exposed couplings (when applicable).
 - a. Design: Steel middle ring with two (2) steel follower rings and two (2) wedge section gaskets. Gaskets when used for air service shall be EPDM rated up to 240°F, 280 degrees intermittent exposure. Gaskets when used for water service shall be isoprene rated for -20 to 180°F.
 - b. Bolting: Steel bolts to properly compress the gaskets.
 - c. Acceptable Manufacturers: Dresser Manufacturing Co. - Style 38, Rockwell International - Style 411, or an approved equal by the Engineer.
 2. Buried Couplings (when applicable)
 - a. Type: Cast iron middle rings (with pipe stops removed) with two (2) malleable iron follower rings (with ribbed construction) and two (2) wedge-section gaskets.
 - b. Bolting: Bolts and nuts for buried couplings, shall be AISI Type 304 stainless steel conforming to ASTM A193, Grade B8 for bolts, and ASTM A194, Grade 8 for nuts. Bolts and nuts greater than 1 $\frac{1}{8}$ -inches shall be carbon steel, ASTM A307, Grade B, with cadmium plating, ASTM B776, Type NS.
 - c. Acceptable Manufacturers: Dresser Manufacturing Co. - Style 53, Smith-Blair, Inc. - Style 411, Rockwell - Style 441, or an approved equal by the Engineer.
- C. Split Type Couplings (when applicable)
 1. Material: Malleable or ductile iron.
 2. Design: Grooved or shouldered end pipe with minimum wall thickness as required so as not to weaken pipe.

3. Segmented Casting: Two segments for ¾-inch through 14-inch pipe sizes, four segments for 15-inch through 24-inch pipe sizes, and six segments for pipe sizes over 24-inch.
4. Gasket: Two (2) end O-ring gaskets bonded to sealing pad, ASTM D2000 elastomer.
 - a. Air Service: EPDM rated up to 240°F, 280 degrees intermittent exposure.
 - b. Water Service: Isoprene rated -20 to 180°F.
5. Coating: Enamel
6. Bolting: Carbon steel
7. Acceptable Manufacturers: Victaulic Company of America, Style 77, Gustina-Bacon Co., Depend-O-Lok, or Brico Industries, Inc.

D. Flanged Adapters (when applicable)

1. Design: For joining plain end or grooved end pipe to flanged pipes and fittings.
2. Adapter Size: Conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150-pound standard unless otherwise required for connections.
3. Exposed Sleeve Type
 - a. Material: Steel
 - b. Coating: Enamel
 - c. Bolting: Carbon steel
 - d. Acceptable Manufacturers: Dresser Manufacturing Co. - Style 128 for cast iron, ductile iron and steel pipes with diameters of 2-inches through 96 inches, or an approved equal by the Engineer.
4. Buried Sleeve Type
 - a. Material: Cast iron
 - b. Bolting: Type 304 stainless steel conforming to ASTM A193, Grade B8 for bolts, and ASTM A194, Grade 8 for nuts and washers. Bolts and

nuts greater than 1½-inches shall be carbon steel, ASTM A307, Grade B, with cadmium plating, ASTM A165, Type NS.

- c. Acceptable Manufacturers: Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile, iron, and steel pipes with diameters of 3-inches through 12-inches, or an approved equal by the Engineer.

5. Split Type

- a. Material: Malleable or ductile iron.
- b. Design: For use with grooved or shouldered end pipe.
- c. Coating: Enamel
- d. Acceptable Manufacturers: Victaulic Company of America - Style 741 for pipe diameters of 2-inches through 12-inches, Victaulic Company of America - Style 742 for pipe diameters of 14-inches through 16-inches, or an approved equal by the Engineer.

E. Type 1 Expansion/Deflection Joints (for above or below ground connection to hydraulic tankage; for settlement greater than 3-inches or 6 degrees; as indicated on the Contract Drawings):

- 1. Type: Single or double ball joint and expansion sleeve with stop collars.
- 2. Materials: Ductile iron (60-42-10) AWWA/ANSI C153/A21.53.
- 3. Coating: Fusion bonded epoxy (15-mils) AWWA C213.
- 4. Minimum Deflection/Expansion (simultaneous):
 - a. Single ball: 15 degrees and 4-inches.
 - b. Double ball: 30 degrees and 4-inches.
- 5. Minimum Pressure Rating: Equal or greater than connecting piping.
- 6. Manufacturer: EBAA Iron, Inc., Flex-Tend, or XTRA-TR FLEX by U.S. Pipe.

F. Type 2 Deflection/Expansion Joints (for above or below ground connection to hydraulic tankage; for settlements less than or equal to 3-inches or 6 degrees; as indicated on the Contract Drawings):

- 1. Type: Mechanical joint long pattern solid sleeve with field installed restrained joints.

2. Manufacturer: EBAA Iron, Inc. or U.S. Pipe.

2.05 ACCESSORIES

A. Joint Harnesses

1. Tie bolts or studs shall be as shown in Table 15129-C. Bolt or stud material shall conform to ASTM A193, Grade B7. Nuts shall conform to ASTM A194, Grade 2H. Lug material shall conform to ASTM A36, ASTM A283, Grade B, C, or D, or ASTM A285, Grade C. Lug dimensions shall be as shown in AWWA Manual M11, Table 19.7.
2. Select number and size of bolts based on the test pressure. For test pressures less than or equal to 150-psi, use the 150-psi design in Table 15129-C. For test pressures between 150 and 300-psi, use the 300-psi design in the Table 15129-C.
3. Provide washer for each lug. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8-inch.

B. Bolts and Nuts for Flanges

1. Bolts and Nuts for flanges located indoors and in enclosed vaults and structures shall be carbon steel, ASTM A307, Grade B.
2. Bolts and nuts for buried and submerged flanges, flanges in open vaults and structures, and flanges located outdoors above ground shall be AISI Type 304 stainless steel conforming to ASTM A193, Grade B8 for bolts, and ASTM A194, Grade 8 for nuts. Bolts and nuts greater than 1 1/8-inches shall be carbon steel, ASTM A307, Grade B, with cadmium plating, ASTM B766, Type NS.
3. Bolts used in flange insulation kits shall conform to ASTM A193, Grade B7. Nuts shall comply with ASTM A194, Grade 2H.
4. Provide washers for each nut. Washers shall be of the same material as the nuts.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Flexible Rubber Type Connectors

1. Remove dirt, rust and burrs from metal flange faces. Bolt holes shall be aligned.
2. Pipe lines shall be properly supported and guided to prevent excessive loads on flexible connectors. Also, vibration isolated anchors shall be installed on each side of the flexible connector. If this is not practical, control units shall be used.
3. Pipe lines shall be properly aligned to within 1/8-inch maximum initial misalignment. Do not twist beyond their allowed torsional ratings as shown on Table 15129-A.
4. Make sure the flexible connector being installed meets with the service conditions anticipated. Attach to each flexible connector a card showing movement, pressure and temperature ratings.
5. Apply a graphite/water solution or glycerin to the rubber flange faces. Never use a petroleum product or adhesive on the flange faces.
6. Insert bolts from the arch side, behind the retaining ring, so that they do not interfere with the arch of the expansion joint. Use washers on all bolts at splits in the retaining ring.
7. Tighten all bolts gradually and equally by alternating around the flange in a clockwise direction. The bolts will be properly torqued and the flange sealed when the edges of the rubber flanges bulge slightly.

B. Sleeve Type Connectors

1. Thoroughly clean pipe ends for a distance of 8-inches from the ends prior to installing couplings, and use soapy water as a gasket lubricant.
2. Slip a follower ring and gasket (in that order) over each pipe and place the middle ring centered over the joint.
3. Insert the other pipe length into the middle ring the distance.
4. Press the gaskets and followers evenly and firmly into the middle ring flares.
5. Insert the bolts, finger tighten and progressively tighten diametrically opposite nuts uniformly around the adapter with a torque wrench applying the torque recommended by the manufacturer.
6. Insert and tighten the tapered threaded lock pins.

7. Insert the nuts and bolts for the flange, finger tighten and progressively tighten diametrically opposite bolts uniformly around the flange to the torque recommended by the manufacturer.
8. Install thrust rods, supports and other provisions to properly support pipe weight and axial equipment loads.

3.02 HYDROSTATIC TESTING

- A. Hydrostatically test flexible pipe couplings and joints in place with the pipe being tested.

TABLE 33 33 26 – A

PRESSURE AND MOTION CAPABILITY OF SINGLE ARCH
FLEXIBLE CONNECTORS

Size I.D. (inches)	Working Pressure (PSIG)	Angular Movement (Degrees)	Torsional Movement (Degrees)	Axial Compression (Inches)	Axial Elongation (Inches)	Lateral Deflection (Inches)
2 - 4	165	19 - 10	3	7/16	1/4	1/2
5 - 12	140	8 - 5	3	7/16	1/4	1/2
14	85	4	2	11/16	3/8	1/2
16 - 24	65	3	1	13/16	7/16	1/2
26 - 66	55	2	1	15/16	1/2	1/2
68 - 96	45	1	1	1 1/16	9/16	1/2
102 - 108	40	3/4	3/4 - 1/2	1 1/16	9/16	1/2
120 - 144	30	2/3 - 1/2	1/2 - 1/3	1 1/16	9/16	1/2

Table 33 33 26 – B

CONTROL RODS AND GUSSETS
SIZE VS. PRESSURE RATING

Size (Inches)	Gusset Plate	Rod	NUMBER OF RODS				
	Thickness	Diameter	2	3	4	5	6
	(Inches)	(Inches)	PRESSURE PSIG				
2	3/8	5/8	200				
2½	3/8	5/8	200				
3	3/8	5/8	200				
4	3/8	5/8	200				
5	1/2	5/8	200				
6	1/2	5/8	140	200			
8	9/16	3/4	140	190			
10	3/4	1	140	190			
12	3/4	1.0	140	190			
14	3/4	1.0	85	130			
16	3/4	1⅛	65	110			
18	3/4	1⅛	65	110			
20	3/4	1⅛	65	110			
22	1	1¼	65	100			
24	1	1¼	65	100			
26	1	1¼	55	85			
28	1¼	1½	55	90			
30	1¼	1½	55	90			
34	1½	1⅝	55	90			
36	1½	1⅝	55	90			
40	1½	1½	35	55	75	90	
42	1½	1⅝	40	55	80	90	
44	1½	1½	35	55	75	90	
48	1½	1⅝	35	55	75	90	
50	1½	2.0	45	65	90	90	
54	1⅞	2.0	35	55	75	95	
56	1⅞	2.0	35	55	70	90	
60	1⅞	2.0	30	45	60	80	
62	1⅞	2.0	30	45	60	75	
66	1⅞	2.0	25	40	55	65	80
72	1⅞	2.0	20	35	45	55	70
78	2.0	2¼	25	35	45	60	75
84	2.0	2¼	20	30	45	55	65
90	2½	2½	20	35	45	60	70
96	2½	2¾	25	35	45	65	75

TABLE 33 33 26 - C

TIE BOLTS OR STUD REQUIREMENTS
FOR FLEXIBLE PIPE COUPLINGS

Tie Bolt or Stud Minimum Requirements

Nominal Pipe Size (Inches)	<u>150 psi</u>		<u>300 psi</u>	
	<u>No. Bolts Or Studs</u>	<u>Size (Inches)</u>	<u>No Bolts Or Studs</u>	<u>Size (Inches)</u>
2	2	5/8	2	5/8
3	2	5/8	2	5/8
4	2	5/8	2	5/8
6	2	5/8	2	5/8
8	2	5/8	2	5/8
10	2	5/8	2	3/4
12	2	3/4	2	7/8
14	2	3/4	2	1
16	2	7/8	2	1¼
18	2	1	2	1⅜
20	2	1	2	1½
24	4	1	4	1¼
30	4	1⅝	4	1½
36	4	1¼	4	1¾
42	4	1½	6	1⅝
48	6	1⅜	6	1⅞
54	6	1½	6	2¼
60	6	1⅝	8	2
66	6	1¾	8	2¼
72	6	1⅞	10	2¼
84	6	2¼	12	2¼
96	8	2¼	14	2¼

END OF SECTION

SECTION 40 90 00

PROCESS INSTRUMENTATION AND CONTROL SYSTEM

GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01. SCOPE OF WORK

- A. The overall system general requirements are given in this section. These requirements apply to each additional section of these specifications as noted herein and as specified in the associated sections.
- B. Work includes engineering, furnishing, installing, testing, documenting and placing in operation the complete Process Instrumentation and Control System (PICS). Training of the OWNER's personnel is also included. The work is specified in this Section and as further specified in the following sections:
 - 1. Specification Section 40 90 10: Field Instruments.
 - 2. Specification Section 40 90 15: Control Panels.
 - 3. Specification Section 40 90 25: Programmable Logic Controller (PLC) System.
 - 4. Specification Section 40 90 26: Programmable Logic Controller (PLC) Programming.
 - 5. Specification Section 40 90 30: Remote Telemetry Unit.
- C. All work covered by this specification shall be performed by one of the following firms henceforth referred to as the SYSTEM SUPPLIER:
 - 1. Commerce Controls, Detroit Michigan
 - 2. Revere Controls, Birmingham, Al.
 - 3. Barneys Pumps/Unitron Controls, Lakeland, Fl.
 - 4. C2I, Atlanta, Ga
- D. The SYSTEM SUPPLIER shall furnish all labor, materials, equipment, programming, services and incidentals required to install and place into operation a digital computer-based PICS configured as shown on the Contract Drawings, and as specified herein.
- E. The SYSTEM SUPPLIER shall provide all equipment, materials, programming, software, modifications to existing equipment, calibrations and services that are required to successfully interface and interconnect the PICS and any other control

systems and associated equipment that are specified or designated in any drawings or provisions of these specifications for the purpose of providing a fully integrated and functional control system.

- F. 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.
- G. It is the intent of these Contract Documents that the SYSTEM SUPPLIER be retained by the CONTRACTOR to have overall responsibility for designing, furnishing, interfacing, adjusting, testing, documenting, and starting-up the various PICS equipment described in the Contract Documents. The specified intent is that the SYSTEM SUPPLIER will have overall responsibility for making sure the various systems, trades, suppliers, vendors, subcontractors, etc. come together as a complete coordinated system which will reliably perform the specified functions.
- H. The CONTRACTOR shall ensure that the SYSTEM SUPPLIER coordinates closely with suppliers of other specialty equipment to ensure the required inputs and outputs for the PICS are available.
- I. Instrumentation and control systems for this project are intended to be supplied completely under this section. All control panels shall be supplied through the SYSTEM SUPPLIER; however, some special control panels and devices specifically called out in other specification sections are to be part of those sections, furnished with that equipment. The instruments and controls shall, however, be furnished in conformance to and in coordination with, this section.
- J. Division of Work. It is the ultimate responsibility of the CONTRACTOR to furnish a complete and fully operable PICS that reliably performs the specified functions. The CONTRACTOR is to assume full responsibility for additional costs which may result from unauthorized deviations from the specifications. The CONTRACTOR is to establish the actual division of work with the minimum requirements as specified herein
- K. The SYSTEM SUPPLIER shall be responsible for:
 - 1. The integration of the system including the PLC networking, panel layouts and wiring, PLC programming, VFD programming and configuration, and network communications programming.
 - 2. All hardware and software submittals. The SYSTEM SUPPLIER shall develop the panel shop drawings, wiring diagrams, plumbing diagrams, PLC hardware configuration drawings and layouts, software documentation, and all other submittals defined herein and in the

specification sections identified in paragraph 1.01B hereof. Coordination with the CONTRACTOR and other subcontractors shall be the responsibility of the SYSTEM SUPPLIER.

3. The final system operation and reliability. All required tests and training shall be under the on-site supervision of the SYSTEM SUPPLIER.
4. Ordering, fabrication, assembly, delivery and start-up of the PICS. All panel fabrication defined in Specification Section 40 90 15 shall be performed at the SYSTEM SUPPLIER's shop.
5. Obtaining from the CONTRACTOR the required information on those field elements, equipment starters, valve actuators, chemical feed equipment, local control panels, and other control equipment or devices that are required to be interfaced with, but that are not provided with the PICS in order to provide full system coordination regarding interface, function, testing, and adjustment requirements.
6. Providing accessory devices including furnishing and installation of networking interface cards, interposing relays, control switches and signal converters necessary to perform the intent as described by the control strategies and services necessary to achieve a fully integrated and operational system as shown on the Contract Drawings and defined in the Specifications.
7. Coordinating all interface requirements with mechanical and electrical system suppliers and furnishing any signal isolation devices that might be required In order to insure compatibility between all equipment.
8. Providing any special manufacturer's cables required.
9. Defining the final installation and connection requirements of the PICS at the jobsite through development of interconnection diagrams.
10. Verifying correctness of all final power and signal connections to the PICS. The SYSTEM SUPPLIER shall make final adjustments to and calibrate all field elements provided with the PICS.
11. Ensuring that:
 - a) All components provided under this section are properly installed.
 - b) The proper type, size and number of control wires with their conduits and junction boxes are provided and installed.
 - c) Proper electric power circuits are provided for all components and systems.

L. The CONTRACTOR shall be responsible for:

1. Including within the electrical subcontractor's scope:
 - a) Provision, installation and termination of field and power wiring to PICS supplied control panels and field elements. Termination shall be made in accordance with final accepted interconnection diagrams developed by the SYSTEM SUPPLIER. The electrical subcontractor shall mark on the interconnect diagram the field wire numbers used for each termination point. The SYSTEM SUPPLIER shall finalize the interconnect diagrams by including these field wire numbers in the final as built version.
 - b) Installation and termination of all specialty cables furnished by the SYSTEM SUPPLIER.
 2. Including within the mechanical subcontractor's scope installation of any in-line instrumentation. Installation shall be made in accordance with the manufacturer's recommendations and under the direction of the SYSTEM SUPPLIER.
 3. Equipment storage and protection until installed following the storage and handling instructions recommended by the SYSTEM SUPPLIER. Anti-static and winterization requirements shall be per the SYSTEM SUPPLIER's instructions and the SYSTEM SUPPLIER shall periodically verify that these instructions are followed.
 4. Incorporating all necessary components into the system. Schedules included in the referenced specification sections do not necessarily indicate the complete component requirements of the PICS.
 5. Ensuring that the SYSTEM SUPPLIER coordinates work with other Divisions and Sections of the Specifications.
 6. Requiring the SYSTEM SUPPLIER to observe and advise on the installation of equipment furnished by SYSTEM SUPPLIER and installed by CONTRACTOR to the extent required to certify, with the operational check-out tests, that the equipment will perform as required.
 7. Ensuring that information on equipment provided under other Divisions and needed by the SYSTEM SUPPLIER to coordinate the PICS is provided in a timely manner.
- M. Equipment found to be defective prior to system acceptance shall be replaced and installed at no additional cost to the OWNER.
- N. In the bid price, the SYSTEM SUPPLIER shall provide for obtaining the services of authorized field personnel from the manufacturers of specialty instruments and from the suppliers of application software packages as necessary. Should these personnel be required during installation, start-up and checkout of the respective

portions of the PICS, such services shall be provided at no additional cost to the OWNER.

1.02. RELATED WORK

- A. Division 26 - Electrical. All conduits are provided and installed under Division 26, Electrical. With the exception of certain specified special manufacturer's cables, all wiring and cables are provided and installed under Division 26, Electrical.
- B. Field devices such as motorized valves, pump motors, solenoid valves, etc. and local control panels for specialized subsystems such as chemical feed systems, etc. are supplied and installed under other Divisions of these Specifications.

1.03. SYSTEM DESCRIPTION

- A. Site monitoring and control shall be provided by an Allen Bradley CompactLogix Programmable Logic Controller (PLC) based Process Control Panel No.1 (PCP-1). PCP-1 shall be a free-standing NEMA 12 steel enclosure located in the Electrical Building.
- B. Pump Variable Frequency Drives (VFD) and certain power equipment shall be monitored and/or controlled by the PLC using Ethernet/IP protocol via a master Ethernet switch within PCP-1.
- C. On-site operator monitoring and control shall be provided by an Operator Interface Terminal (OIT) front-panel mounted on PCP-1.
- D. Remote monitoring of the site shall be provided by a Remote Telemetry Unit (RTU) furnished by others under Section 40 90 30.
- E. Back-up Control Panels (BUCP) shall be provided to assume operation of site equipment in the event of a PLC failure. BUCP-1 shall control the high pressure distribution pumps (pumps 1 through 4) and BUCP-2 shall control the low pressure distribution pumps (pumps 5 through 7). See elementary diagrams on drawings E-7 and E-8.

1.04. SYSTEM INTEGRATION PLAN

- A. Prior to any other shop drawing submittals the SYSTEM SUPPLIER shall submit a System Integration Plan (SIP). Other submittals received before this submittal will be returned without review.
- B. The SIP shall identify, and provide details of, all PICS functions. This shall include the following elements:
 - 1. Field.
 - 2. PLC.

3. System Inputs and Outputs.
 4. Network/communications.
- C. Field. Provide an Excel spreadsheet that covers all field instruments. For each instrument define the following:
1. Tag Number.
 2. Instrument Type.
 3. Specification Section supplied under.
 4. Signal Type.
 5. Range or On/Off states as applicable.
- D. PLC. Provide an Excel spreadsheet that covers all PLC. For each, define the following:
1. PLC Designation Number.
 2. Location.
 3. A list of I/O modules.
- E. System Inputs and Outputs (I/O). Provide an Excel spreadsheet that lists all system I/O for the complete PICS. For each point, the list shall include the following:
1. PICS database tag number.
 2. Signal Description.
 3. I/O Type.
 4. Range or On/Off state as applicable.
- F. Network/communications. This shall provide a tabular listing identifying the following:
1. Ethernet switches listed by port and including spares.
 2. Connected equipment to each port.
 3. Spreadsheet listing all network connected components. For each, identify the network connection point and proposed or existing IP address.
- G. Following PLC programming, revise the system I/O spreadsheet to include all pseudo points (differentiated from physical I/O) that are used by the OIT.

- H. Provide a fully updated SIP as part of the final system documentation.

1.05. SUBMITTALS

- A. Furnish, as prescribed under the General Requirements, all required submittals covering the items included under this section and its associated sections of the work.
- B. Submit complete, neat, orderly, and indexed submittal packages. Handwritten diagrams are not acceptable and all documentation submittals shall be made using CADD generated utilities.
- C. Partial submittals or submittals that do not contain sufficient information for complete review or are unclear will not be reviewed and will be returned by the Engineer as not approved.
- D. All submitted component data sheets shall be marked to specifically identify the model/part numbers to be furnished.
- E. Provide all shop drawing submittals on thumb drive in PDF format.
- F. In addition to the shop drawing submittals required in the related specification sections, submit the submittals defined below covering the complete system.
 - 1. System Performance. This submittal shall be a written description of how the operator will control the system and the system's subsequent response. Every piece of controllable equipment shall be separately described and the following information included:
 - a) Use of local manual controls.
 - b) Use of OIT software controls.
 - c) Use of automatic controls.
 - 2. Each functional description shall specifically identify any interlocks (hardware and software) and OIT alarms generated.
 - 3. Operator Screens. This submittal shall include color copies of all proposed OIT operator screens.
 - 4. Field Acceptance Test Plan. This submittal shall define the steps to be conducted during the required witnessed acceptance testing. The test shall be conducted in accordance with the general requirements set forth in Part 3 hereof. The submitted plan shall meet the following requirements:
 - a) Each of the equipment covered in the system performance submittal shall be tested.

- b) For each equipment test, the required operator control actions and system response shall be demonstrated on the complete system, including each operator action, the response and appropriate HMI display/alarm updates.
- G. The Contractor and SYSTEM SUPPLIER are hereby specifically advised that the above submittals shall be Approved or Approved As Noted prior to any witnessed performance testing.
- H. Loop Diagram Submittal. This submittal may be made in conjunction with the submittals required under related specification sections. Loop diagrams, consisting of complete wiring and/or plumbing diagrams for each control loop showing all terminal numbers, the location of the dc power supply, the location of any booster relays or common dropping resistors, surge arrestors, etc. The loop diagrams shall be divided into four areas for identification of element locations: PICS I/O point(s), panel face, back-of-panel, and field, respectively.
- I. Test Procedures: Submit the procedures proposed to be followed during all required testing. Procedures shall include test descriptions, forms, and check lists to be used to control and document the required tests.
- J. Test Reports: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures to the Engineer.

1.06. FINAL DOCUMENTATION

- A. After the demonstration tests have been completed and as a part of the final acceptance requirements, submit the PICS record drawings. Record drawings shall include, corrected for any changes that may have been made up through Substantial Completion:
 - 1. System block diagram.
 - 2. Network architecture diagram.
 - 3. Instrument loop wiring diagrams.
 - 4. Panel wiring diagrams.
 - 5. Panel elevations.
 - 6. Interconnection diagrams showing terminal numbers at each wiring termination.
- B. Record drawings shall be developed or converted to AutoCAD. Provide two copies of all AutoCAD files on separate Compact Disks.
- C. Operating and Maintenance (O&M) Manuals: Provide the specified number of complete sets of three-ring bound O&M manuals in accordance with Division 1.

Provide separate manuals for each Specification Section, clearly marked. Include descriptive material, drawings, and figures bound in appropriate places. Include:

1. Cross references to 3rd party O&M manuals.
 2. Additional operating and maintenance instructions in sufficient detail to facilitate the operation, removal, installation, adjustment, calibration and maintenance of each component provided with the PICS.
 3. Internal wiring diagrams (not already shown on the panel wiring diagram record drawings) for all components provided in the PICS that clearly show all terminal block number designations and wire numbers.
 4. Bill of Materials identifying the manufacturer and complete part number of all components.
 5. All the submittal data for each component from the approved shop drawing submittals with corrections made on approved as noted items.
 6. A Compact Disk containing the shop drawing data in PDF format in the binder sleeve.
- D. Provide a final System Integration Plan.
- E. Refer to the individual specification sections of the PICS for final documentation requirements that are in addition to the above.

1.07. QUALITY CONTROL

- A. Base bids for the SYSTEM SUPPLIER shall be as listed in the Contract Proposal. SYSTEM SUPPLIERS seeking ENGINEER approval shall have extensive experience in systems of similar size and complexity. Panel fabrication shop shall be a UL listed panel shop. Acceptance of alternates shall be made based on price, location of the fabrication shop, accessibility of personnel, PLC programming knowledge, and OWNER confidence. The SYSTEM SUPPLIER shall be subcontracted by and paid by the CONTRACTOR.
- B. The SYSTEM SUPPLIER shall meet all of the requirements of these specifications, and, unless specifically stated otherwise, no prior acceptance of any subsystem, equipment, or materials has been made.
- C. All equipment furnished by the SYSTEM SUPPLIER shall be of the latest and most recent design and shall have overall accuracy as guaranteed by the manufacturer.
- D. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

- E. Component equipment shall be as supplied by one of the manufacturers named in the individual specification sections or approved equal. The design of the PICS is based on the first-named manufacturer's equipment if there is a difference.
- F. To facilitate the OWNER's operation and maintenance, products shall be of the same major manufacturer, with panel mounted devices of the same type and model as far as possible.
- G. In order to insure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems, and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained.
- H. The SYSTEM SUPPLIER shall designate a single point of contact for interface with the ENGINEER on this project. The ENGINEER reserves the sole right to approve or reject this point of contact.
- I. The SYSTEM SUPPLIER's selected project personnel shall meet the following requirements:
 - 1. Project engineer shall have at least 10 years' experience in installing similar systems and shall have a minimum of secondary education in the field of electronics or similar technical discipline.
 - 2. Project technician assisting the project engineer for field element calibration and check out shall have at least five years experience in installing similar systems.
 - 3. Key staff resumes shall be submitted for ENGINEER's approval with the Project Plan as further detailed under submittals.
- J. Service Facility: The SYSTEM SUPPLIER shall have an established service facility from which qualified technical service personnel and parts may be dispatched upon call. Such a service facility shall be no more than six (6) hours travel time from the jobsite.
- K. The SYSTEM SUPPLIER shall provide experienced personnel on-site to coordinate and/or perform installation, termination, and adjustment; on-site testing; OWNER training; and startup assistance for the PICS.
- L. The SYSTEM SUPPLIER shall provide, on-site, an experienced project engineer to supervise and coordinate all of the on-site PICS activities. An experienced technician may be provided to assist the project engineer in field element installation, field calibration, and checkout tests. The SYSTEM SUPPLIER's project engineer shall be on-site during the period required to effect all of the critical on-site activities related to the PICS, particularly the software debugging, PICS training, and witnessed testing activities.

1.08. STANDARDS

- A. 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.
- B. Any equipment that does not have a UL, FM CSA, or other approved 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 Electric Code and OSHA requirements.
- C. Any additional work needed resulting from any deviation from codes or local requirements shall be at no additional cost to the OWNER.
- D. International Society of Automation (ISA) and National Electrical Manufacturers Association (NEMA) standards shall be used where applicable in the design of the PICS.
- E. All equipment used on this project to test and calibrate the installed equipment shall be in calibration at the time of use. Calibration shall be traceable to National Institute of Standards (NIS - formally NBS) calibration standards.
- F. For the purposes of uniformity and conformance to industry standard, provide analog signal transmission modes of electronic 4-20 ma DC. No other signal characteristics are acceptable.
- G. Discrete signals are two-state logic signals. Use 120V ac sources on all discrete signals unless otherwise noted or shown.
- H. Provide appropriately sized electrical transient protection devices for all electrical elements of the system as further defined in the individual specification sections. For field mounted devices, provide protector enclosures to the electrical Subcontractor for mounting and installation.

1.09. WARRANTY AND GUARANTEES

- A. In accordance with Division 1, the SYSTEM SUPPLIER shall furnish to the OWNER a written two year guarantee commencing with final acceptance, that all equipment and parts thereof, material and/or workmanship for the field elements, instruments, and control panels are of top quality and free from defects.
- B. The SYSTEM SUPPLIER shall guarantee all equipment whether or not of his own manufacture.

1.10. SPARES AND EXPENDABLES

- A. Obtain from the manufacturer(s) and provide the recommended critical spare parts as part of the work. Refer to the individual requirements listed in the associated

specification sections for the PICS for specific parts to be provided as a minimum. The spare parts are the property of the OWNER.

- B. Obtain from the manufacturer(s) and furnish any special tools, calibration equipment and testing apparatus required for the proper adjustment and maintenance of the material provided.

PART 2 - PRODUCTS (THIS PART NOT USED)

PART 3 - EXECUTION

3.01. SEQUENCE OF WORK

- A. Prerequisite Activities and Lead Times: Do not start the following key project activities until the listed prerequisite activities have been completed and lead times have been satisfied:
 - 1. Hardware Purchasing, Fabrication, and Assembly: Associated design related submittals completed (no exceptions, or approved as noted).
 - 2. Shipment: Completion and approval of all design related submittals.
 - 3. Startup: Operational Checkout Tests.
 - 4. OWNER Training: Owner training completed and O&M manuals delivered.
 - 5. Demonstration Tests: Operational Check-out Tests, Startup, OWNER Training, and Demonstration Test Procedures must be complete. Give 4 weeks' notice prior to the planned test start date.
- B. Consoles, Panels, and Panel Mounted Equipment: Consoles, panels, and panel mounted equipment shall be assembled as far as possible at the SYSTEM SUPPLIER's shop. No work, other than correction of minor defects or minor transit damage, shall be done on the panels at the jobsite.

3.02. PAYMENTS

- A. General: All work provided under this Section and its associated Sections for the PICS shall be paid for in accordance with the approved payment Schedule of Values submitted by the CONTRACTOR. The approved Schedule of Values will be the basis for partial payment for work provided for the PICS.
- B. Partial Payment for Work Completed: The breakdown in the Schedule of Values allows for the partial payment of work completed for the PICS. Before partial payment is considered for approval, each specific activity must be completed.

- C. Substantial Completion: Substantial Completion for the project is as defined in the General Conditions. However, the following requirements must be fulfilled before consideration will be given for Substantial Completion of the PICS:
 - 1. All PICS submittals have been completed.
 - 2. The PICS has successfully completed the Demonstration Tests.
 - 3. The required Owner training has been implemented.
 - 4. All spares, expendables, and test equipment have been received by OWNER.
- D. Final Acceptance: PICS final acceptance is defined as the date when the ENGINEER issues a written notice of final acceptance. For this Section, the following must have been completed before consideration will be given to the issuance of notice of final acceptance:
 - 1. All punch-list items have been checked off.
 - 2. Revisions to the PICS O&M Manuals have been made (that may have resulted from the Demonstration Tests).
- E. Partial Payment Limits: The partial payments for work provided for the PICS shall satisfy the following limiting maximum criteria (percentages of the lump sum pay item for the PICS):
 - 1. Submittals (not including O&M Manuals) 15%
 - 2. Training 5%
 - 3. O&M Manuals 5%
 - 4. Demonstration Tests 10%

3.03. PRODUCT HANDLING

- A. Store and protect equipment until installation following the storage and handling instructions recommended by the equipment manufacturers. Place special emphasis on proper anti-static protection of sensitive equipment.
- B. Protection During Construction: Throughout this Contract, provide protection for materials and equipment against loss or damage and from the effects of weather. Prior to installation, store items in indoor, dry locations. Provide heating in storage areas for items subject to corrosion under damp conditions. Provide covers for panels and other elements that may be exposed to dusty construction environments. Specific storage requirements shall be in accordance with the SYSTEM SUPPLIER's recommendations.

- C. Corrosion Protection: Protect all consoles, panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules. Prior to shipment, include capsules in the shipping containers, and equipment as recommended by the capsule manufacturer. During the construction period, periodically replace the capsules in accordance with the capsule manufacturer's recommendations. Replace all capsules just prior to Final Acceptance.
- D. ESD Protection: Provide for the proper handling, storage, and environmental conditions required for the PICS components deemed static sensitive by the equipment manufacturer. Utilize anti-stat wrist straps and matting during installation of these items to prevent component degradation. Flooring used in control areas shall be reviewed and approved by the SYSTEM SUPPLIER.
- E. Adequately pack manufactured material to prevent damage during shipping, handling, storage and erection. Pack all material shipped to the project site in a container properly marked for identification. Use blocks and padding to prevent movement.
- F. Ship materials that must be handled with the aid of mechanical tools in wood-framed crates.
- G. Ship all materials to the project site with at least one layer of plastic wrapping or other approved means to make it weatherproof. Anti-stat protection shall be provided for all sensitive equipment.
- H. Inspect the material prior to removing it from the carrier. Do not unwrap equipment until it is ready to be installed. If any damage is observed, immediately notify the carrier so that a claim can be made. If no such notice is given, the material shall be assumed to be in undamaged condition, and any subsequent damage that is discovered shall be repaired and replaced at no additional expense to the OWNER.
- I. The CONTRACTOR shall be responsible for any damage charges resulting from the handling of the materials.

3.04. INSTALLATION

- A. Material and Equipment Installation: Install the PICS in locations indicated on the Drawings and follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturers' instruction and these Contract Documents, follow ENGINEER's decision, at no additional cost. Keep copy of manufacturers' instructions on the jobsite available for review at all times.
- B. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance. Coordinate I&C work with the OWNER and work of other trades to

avoid conflicts, errors, delays, and unnecessary interference with operation of the existing plant during construction.

- C. Provide finish on instruments and accessories that protects against corrosion by the elements in the environment in which they are to be installed. Finish both the interior and exterior of enclosures. Provide extra paint of each color used in the material from the manufacturer for touch-up purposes.
- D. Equipment Finish: Provide materials and equipment with manufacturer's standard finish system. Provide manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.
- E. Cleaning and Touch-up Painting: Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch-up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. Clean and polish the exterior of all panels and enclosures upon the completion of the demonstration tests.
- F. Control Valves: Verify correctness of installation. Verify calibration and adjustment of all positioners and I/P transducers and verify correct control action. Verify position switch settings. Verify opening and closing speeds and travel stops.

3.05. SYSTEM OPERATING CRITERIA

- A. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two (2) cycles per minute or a magnitude of movement of 0.5 percent full travel.
- B. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
- C. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 2 percent of full scale over a 6:1 operating range.
- D. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position final element.
- E. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 percent of full scale.

- F. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

3.06. TRAINING

- A. The cost of training programs to be conducted with OWNER's personnel shall be included in the Contract price. The training and instruction, insofar as practicable, shall be directly related to the System being supplied.
- B. The SYSTEM SUPPLIER shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
- C. The SYSTEM SUPPLIER shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to OWNER.
- D. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.
- E. All training schedules shall be coordinated with, and at the convenience of the OWNER. Shift training may be required to correspond to the OWNER's working schedule.
- F. Specific details of the nature and duration of training to be provided are defined in the individual specification sections.

3.07. TESTING – GENERAL

- A. All elements of the PICS, both hardware and software, shall be tested to demonstrate that the total system satisfies all of the requirements of the Contract Documents
- B. As a minimum, the testing shall include shop tests, operational check-out tests, and Demonstration Tests.
- C. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system producing the correct result (effect), the specific test requirements will have been satisfied.
- D. All tests shall be conducted in accordance with, and documented on, prior approved procedures, forms, and checklists. Each specific test to be performed shall be described and a space provided after it for signoff by the appropriate party after its satisfactory completion. Copies of these signoff test procedures, forms, and checklists will constitute the required test documentation.
- E. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical

to test with real process variables, equipment, and data, provide suitable means of simulation. Define these simulation techniques in the test procedures.

- F. The SYSTEM SUPPLIER shall coordinate all of their testing with the CONTRACTOR, the ENGINEER, all affected suppliers, and the OWNER.
- G. The ENGINEER reserves the right to test or retest any and all specified functions whether or not explicitly stated in the approved test procedures. The ENGINEER's decision shall be final regarding the acceptability and completeness of all testing.

3.08. OPERATIONAL READINESS TEST (ORT)

- A. Prior to startup and demonstration testing, certify that the entire installed PICS (inspected, tested and documented) is ready for operation. These inspections and tests shall include Loop/Component inspections and tests. The SYSTEM SUPPLIER shall fully debug problems in the system as a whole. Final approval of control software will not be based on written descriptions of software functions alone, but on actual performance in the field.
- B. Check the entire PICS for proper installation, calibration and adjustment on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and the PICS Specifications.
- C. The Loop/Component Inspections and Tests shall be implemented using approved forms and checklists. Example sheets are provided at the end of this Specification Section. These shall be developed by the SYSTEM SUPPLIER and submitted for approval.
- D. Maintain the Loop Status Reports and Component Calibration Sheets at the jobsite and make them available to the ENGINEER at any time.
- E. Witnessing: These inspections and tests do not require witnessing. However, the ENGINEER will review the Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Check-out Tests. Correct any deficiencies found.
- F. Final Documentation: The completed reports and sheets shall be assembled in one document and submitted together with a completed Manufacturer's Check-Out Certification.

3.09. FIELD ACCEPTANCE TEST (FAT)

- A. Once the PICS has passed the ORT, the SYSTEM SUPPLIER shall perform a witnessed Field Acceptance Test (FAT) on the complete PICS. The FAT shall demonstrate that the PICS is operating and in compliance with the Contract requirements. Each specified function shall be demonstrated on a paragraph-by-paragraph, and site-by-site basis.

- B. Prior to the FAT, the entire installed PICS shall be certified in writing by the CONTRACTOR that it is ready for operation.
- C. The system shall operate for a continuous 100 hours without failure before this test will be considered successful.
- D. The FAT shall cover the entire PICS, including control functions, alarms, and status monitoring. Test procedures used for factory tests may be adopted for these tests if modified as required.

3.10. 30-DAY SYSTEM ACCEPTANCE TEST (SAT)

- A. After completion of the Field Acceptance Tests, the entire system shall operate for a period of 30 consecutive days, under conditions of full plant process operation, without a single non-field repairable malfunction.
- B. Provide complete O&M Manuals for the PICS at the jobsite at least two weeks prior to the SAT.
- C. During this test, plant operating and SYSTEM SUPPLIER personnel shall be present as required. The SYSTEM SUPPLIER is expected to provide personnel for this test who have an intimate knowledge of the hardware and software of the system.
- D. While this test is proceeding, the OWNER shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes.
- E. Any malfunction during the tests shall be analyzed and corrections made by the SYSTEM SUPPLIER. The ENGINEER and/or OWNER will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- F. Any malfunction, during this 30 consecutive day test period, which cannot be corrected within 24 hours of occurrence by the SYSTEM SUPPLIER's personnel, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction.
- G. Upon completion of repairs, by the SYSTEM SUPPLIER, the test shall be repeated as specified herein.
- H. In the event of rejection of any part or function, the SYSTEM SUPPLIER shall perform repairs or replacement within 90 days.
- I. All data base errors must be corrected prior to the start of each test period. The 30-day test will not be considered successful until all databases are correct.
- J. The total availability of the system shall be greater than 99.5 percent during this test period.

1. Availability is given by $\frac{\text{Total Time-Down Time}}{\text{Total Time}}$.
 2. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided, shall not contribute to the availability test times above.
- K. Upon successful completion of the 30-day Site Acceptance Test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the warranty period shall commence.

Loop Check-out Sheet

Project Name:	Owner's Project No. (if applicable):	Page of
Project Owner:	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD				CONTROL CAB		
	LEAK CHECK ₍₁₎			TERM/CONT CHECK ₍₂₎		TERM/CONT CHECK ₍₂₎	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: _____

Date: _____

Instrument Calibration Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	

Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	INPUT	OUTPUT	ERROR (% of range)	INPUT	OUTPUT	ERROR (% of range)
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____

Date Certified: _____

END OF SECTION

SECTION 40 90 10

PROCESS INSTRUMENTATION AND CONTROL SYSTEM

FIELD INSTRUMENTS

PART 1 - GENERAL

1.01. SCOPE OF WORK

- A. This Specification Section covers work related to the various field instruments to be supplied with the Process Instrumentation and Control System (PICS).
- B. Field instrumentation, as specified herein, shall be furnished by the same SYSTEM SUPPLIER furnishing services and equipment as outlined in 40 90 00.

1.02. RELATED WORK

- A. Specification Section 40 90 00 defines work associated with the overall PICS.
- B. Specification Section 40 90 15 defines work associated with control panels and enclosures housing the various elements of the PICS.
- C. Specification Section 40 90 25 defines work associated with the Programmable Logic Controllers (PLCs) that will interface the system with the field instruments defined hereunder.
- D. Physical Installation of field instruments is performed under Division 15, Mechanical.
- E. Provision of all field and power wiring except manufacturer-supplied cables and installation of all such wiring is performed under Division 16, Electrical.

1.03. SUBMITTALS

- A. Submit the following Field Instrumentation Shop Drawings in a single package:
 - 1. Catalog information, descriptive literature, wiring diagrams, and shop drawings on all components of the field instruments, including all miscellaneous electrical and mechanical devices furnished under this section.
 - 2. Individual data sheets for all components of the field instruments to supplement the above information by citing all specific features for each specific component (e.g. scale range, materials of construction, special options included, etc.). Each component data sheet shall bear the component name and instrument tag number designation shown in the Drawings and Specifications.

3. Installation details for all field mounted devices to show conformance with the Contract Documents.
4. Configuration documentation for all programmable devices to indicate actual settings used to set the device scale, range, trip points, and other control parameters.
5. Proposed tag numbers for each specific instrument.

PART 2 - PRODUCTS

2.01. GENERAL REQUIREMENTS

- A. Equipment to be installed in a hazardous area shall meet Class, Group, and Division classification as shown on the Contract Electrical Drawings, or comply with the local or National Electrical Code, whichever is the most stringent requirement.
- B. All instruments requiring plumbing shall utilize stainless steel components as follows:
 1. Test Tap: Shall consist of Crawford Fitting Co. Swagelock quick connects Series QC4-DE, or equal.
 2. Tubing, Stainless Steel: Shall be ASTM A 312, TP 316, seamless, soft annealed with 0.065 inch wall. Fittings shall be ASTM A 276, TP 316 compression or socket weld type.
 3. Valve, Ball: Shall be stainless steel ball valves, Whitey Series 40, Hoke Flamite Series 7100, or equal.
- C. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks.
- D. Instrument cable lengths shall be determined by the SYSTEM SUPPLIER based on actual field installation requirements.
- E. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent. Indicator readouts shall be linear in process units.
- F. Electronic equipment shall utilize printed circuitry suitably coated to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for their purpose, to assure optimum long-term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

2.02. LIGHTNING/SURGE PROTECTION

- A. Surge suppressors and arrestors meeting the requirements of IEEE/ANSI Standard C-62.41 (latest revision) shall be provided on all electronic field instruments.
- B. AC Powered Instruments. Lightning and surge protection shall be provided on both the AC power supply and signal lines. The instrument, a breaker and the surge suppressor shall be mounted on a ½-inch aluminum plate equipped with 1/8 inch sun shields on top and both sides with front panel facing north wherever practical. The mounting plate shall be connected to a ground rod via a #10 gauge wire. The protectors shall meet the following criteria:
 - 1. NEMA 4X small case.
 - 2. Response time of less than five nanoseconds.
 - 3. AC Power protection: IEEE/ANSI Std. C-62.41 rated C3 at 330 Volts clamping level.
 - 4. Signal line protection: 10,000 Amp 8 x 20 microsecond surge, clamped at 36 Volts clamping level.
 - 5. Test jacks for low level signal monitoring.
 - 6. Manufacturer/model: EDCO SLAC series or approved equal.
- C. Loop Powered Instruments. Lightning and surge protection shall be provided on the 4-20 mA DC signal line. The protectors shall meet the following criteria:
 - 1. Encapsulated in Stainless Steel Pipe nipples for in-line conduit mounting.
 - 2. Response time of less than one nanosecond.
 - 3. Capable of withstanding up to 400 occurrences of 500 Amps at 10 x 1 millisecond.
 - 4. Series resistance of 5 ohms per line.
 - 5. Protection of both lines plus shield
 - 6. Manufacturer/model: EDCO SS65 or approved equal

2.03. FIELD INSTRUMENTS

- A. Ultrasonic Level Element and Transmitter. The system shall consist of a sensor (Level Element, LE) that uses a non-contact ultrasonic measurement technique to measure the liquid level in a vessel, tank or basin, interconnecting cable, and electronics unit that produces an analog signal proportional to level (Level Indicating Transmitter, LIT) or, in the case of weir applications, flow (Flow Indicating Transmitter, FIT).

1. System Performance:
 - a) Overall system accuracy shall be plus or minus 0.25 percent of span or 0.1 inches, whichever is greater, automatically compensated for temperature.
 - b) The electronics unit shall contain preset algorithms containing the necessary factors to convert a weir level into a flow value.
 - c) The system shall be field calibratable without the use of external calibrators.
 2. Sensor Materials:
 - a) Chemical tank locations – All Teflon.
 - b) Other locations – PVC and Teflon.
 3. Ratings:
 - a) Electronics Unit – NEMA 4X.
 4. Electrical:
 - a) Power Requirement - 120 VAC plus or minimum 10 percent, 60 Hertz.
 - b) Maximum Power Consumption – 10 Watts.
 5. Functional:
 - a) Span, output, linearization and digital output scaling shall be adjustable at the transmitter.
 - b) Echo status and loss indication shall be provided at the transmitter.
 - c) Electronic unit display: 16 character, backlit LCD.
 6. Manufacturer, Model series:
 - a) Milltronics, Multiranger Plus.
 - b) Endress and Hauser, Prosonic.
 - c) Approved equal.
- B. Pressure Transducer. The pressure transducer shall sense variations in pressure and produce a standard current output signal linear with gage pressure (Pressure Indicating Transmitter, PIT), differential pressure (Differential Pressure Indicating Transmitter, DPIT), flow via square root extraction of differential

(Flow Indicating Transmitter, FIT) or, via inference, level (Level Indicating Transmitter, LIT). The transducer shall use a diaphragm activated cell method to monitor process pressure via impulse piping connected through a valve manifold and, where noted, diaphragm seals.

1. Performance:
 - a) Total accuracy of less than or equal to 0.2% of span for +/- 50 degree temperature changes from 1:1 to 10:1 range down.
 - b) Adjustable zero and span values anywhere within the nominal range.
 - c) Differential transducers shall provide direct reading or integral square-root extraction.
2. Materials:
 - a) Metallic Wetted parts – 316 Stainless Steel.
 - b) Wetted O-rings – Glass filled TFE.
 - c) Fill liquid - NSF approved for use in drinking water applications.
 - d) Electronics Housing – Low copper aluminum with polyurethane paint.
 - e) Mounting hardware – 316 Stainless Steel.
3. Ratings:
 - a) Enclosure – NEMA 4X
4. Electrical:
 - a) Transmitter excitation: 10.5 to 32 Volts DC at up to 18 mA.
5. Options:
 - a) Provide surge/lightning protection within the transmitter.
 - b) Provide 3-way SS valve manifold.
 - c) Provide integral LCD indicator with displayed value in process units.
 - d) Provide minimum half inch process connection.
6. Manufacturer, Model series:

- a) Rosemount, 3051 series.
 - b) Endress & Hauser, CerebarS series.
 - c) Siemens, Sitrans P series.
 - d) Approved equal.
- C. Pressure Switch. The pressure switch shall sense pressure variations by means of a 316 stainless steel bourdon tube and operate a hermetically sealed mercury switch when the pressure reaches an adjustable level. Pressure switches shall be equipped with diaphragm seals where shown on the drawings.
- 1. Performance:
 - a) Adjustable deadband (7 psig minimum) over 10-100 psig measurement range.
 - b) Automatic reset.
 - c) SPDT contacts.
 - d) Setpoint and deadband adjustments visible from outside the enclosure.
 - 2. Materials:
 - a) Pressure Chamber Wetted parts – 316 Stainless Steel.
 - b) Housing – Flanged steel.
 - 3. Ratings:
 - a) NEMA 4X.
 - 4. Electrical:
 - a) Contacts rated 4 Amps at 120 V AC.
 - 5. Manufacturer, Model series:
 - a) Mercoid, DAW.
 - b) Approved equal.
- D. Level Switch, Float. The level switch shall be a direct acting, weighted float suspended on its own cable. As the liquid level rises the float tilts and actuates a hermetically sealed switch inside the float. The cable shall be terminated within a junction box located outside the tank or basin. For multiple float applications, all cables shall terminate in a single junction box.

1. Materials:
 - a) Float wetted part – Polypropylene
 - b) Cable – PVC jacketed
 - c) Junction box – 316 SS
 2. Ratings:
 - a) Junction box – NEMA 4X
 - b) NSF approved for potable water.
 3. Electrical:
 - a) Dry contact rated to 4.5 Amps at 120 VAC
 - b) Normally open or normally closed as required for the application
 4. Options
 - a) Provide stainless steel hanging bar. Attach the float cables to the bar using Kellum grips.
 - b) Provide other supports/mounting accessories as required.
 5. Manufacturer, model:
 - a) Anchor Scientific, Eco-float type G
 - b) Approved equal.
- E. Limit Switch. The limit switch shall detect the closed position of a hatch, door, etc. by means of an actuator. The actuator shall energize the switch while the door is closed.
1. General:
 - a) Actuator orientation: As required for application
 - b) Actuator mechanism: Adjustable lever roller.
 - c) Switch shall not be mounted on the moving portion of the door or hatch.
 2. Materials:
 - a) Normal applications: Phosphate coated zinc with Epoxy coating.

- b) Corrosive locations: All 316 Stainless Steel including actuating lever.
- 3. Ratings:
 - a) NEMA 4X for normal applications.
 - b) NEMA 6 where potential submergence exists.
 - c) Use explosion proof switches with factory installed cable for all Class I rated locations.
- 4. Electrical:
 - a) Normally open and normally closed dry contacts
 - b) Dry contact rated to 10 Amps at 120 VAC
- 5. Options
 - a) Provide stainless steel supports/mounting and strike plates as required.
- 6. Manufacturer, model:
 - a) Honeywell, model HDLS or LSX as applicable
 - b) Approved equal.

2.04. PRESSURE MONITORING PANEL

- A. Provide two Pressure Monitoring Panels; one for high pressure distribution and one for low pressure distribution.
- B. The panel shall be NEMA 12 enclosures located within the Pump Building and furnished complete such that, following installation, it is only necessary to connect it to the sensing taps.
- C. The discharge pressure transducer shall be plumbed within the enclosure to a manifold with a 3-1/2" pressure gauge, shutoff and bleed needle valves having 1/4" female external bulkhead pressure connections in the bottom of the enclosure.
- D. The required standby pressure switches shown in the Contract Drawings shall be installed in this enclosure and connected to a second manifold.
- E. Each instrument shall be equipped with a shut-off valve and a bleed valve.
- F. The panel shall be provided with a window to allow operator's to view the current pressure reading.

- G. All tubing and valves within the panel shall be 304 stainless steel and meet the requirements herein.

2.05. SPARES AND EXPENDABLES

- A. Provide the following spare parts:
 - 1. Five percent (minimum of 2) spare surge protection devices of each type used.

PART 3 - EXECUTION

3.01. INSTALLATION

- A. Install the PICS field instruments in strict accordance with the respective manufacturer's instructions and recommendations, in locations as shown on the Drawings, and as indicated on the installation details of the Drawings.
- B. Fully calibrate each instrument.
- C. Provide surge protection enclosures to the electrical sub-contractor for mounting and installation. The enclosures shall be fully wired internally. Coordinate grounding requirements with Division 16, Electrical.

3.02. TRAINING

- A. Four (4) hours of on-site (field) training shall be conducted at the OWNER's plant site and shall provide detailed hands-on instruction to OWNER's personnel covering all supplied field instruments.
- B. Training shall include:
 - 1. calibration procedures.
 - 2. preventive maintenance methods and timing.
 - 3. fault-finding techniques.
- C. The training shall run at times chosen by the OWNER.

END OF SECTION

SECTION 40 90 15
PROCESS INSTRUMENTATION AND CONTROL SYSTEM
CONTROL PANELS

PART 1 - GENERAL

1.01. SCOPE OF WORK

- A. This Specification Section covers work related to the control panels and enclosures to be supplied with the Process Instrumentation and Control System (PICS).
- B. The control panels, as specified herein, shall be furnished by the same SYSTEM SUPPLIER furnishing services and equipment as defined under Specification Section 40 90 00.
- C. The SYSTEM SUPPLIER shall design, furnish and install all interior wiring within the control panels and furnish complete wiring diagrams showing the electrical circuits inside the panel and interconnections between the panel and the external instruments and components.
- D. Size control panel(s) to adequately dissipate heat generated by equipment mounted inside or on the panel front face.

1.02. RELATED WORK

- A. Specification Section 40 90 00 defines work associated with the overall PICS,
- B. Programmable Logic Controllers (PLC) are to be mounted in control panels hereunder. PLC are defined in Specification Section 40 90 25.

1.03. SUBMITTALS

- A. Submit the following control panel shop drawings in a single package:
 - 1. Layout diagrams for all control panels and enclosures. Include panel elevations (front, side, interior), and sizing. Panel front elevations shall be of sufficient scale to allow all engraved nameplates and inscriptions to be legible without the use of schedules.
 - 2. A complete Bill of Materials for each panel cross-referenced to the panel layout drawings and identifying the manufacturer and complete part number of all components.
 - 3. Wiring diagrams for all control panels. Diagrams shall be complete electrical wiring diagrams showing all components and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc. All wires and terminals shall be numbered on the diagrams, and line cross-

references shall be labeled. Include wiring interface to the PLCs where applicable. Include on these drawings a tag number to identify each component and referenced to a component identification list.

4. Data sheets for all components. The data sheets shall be marked to indicate those portions applicable to the components to be furnished.
5. Power requirements and heat dissipation summary for all control panels. Power requirements shall state required voltages, currents, and phase(s). Heat dissipations shall be maximums and shall be given in Btu/hr. The summary shall be supplemented with calculations.

PART 2 - PRODUCTS

2.01. GENERAL REQUIREMENTS

- A. Equipment to be installed in a hazardous area shall meet Class, Group, and Division classification as shown on the Contract Electrical Drawings, or comply with the local or National Electrical Code, whichever is the most stringent requirement.
- B. Electronic equipment shall utilize printed circuitry suitably coated to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for their purpose, to assure optimum long-term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.
- C. All equipment shall be designed to operate on a 60-Hertz alternating current power source at a normal 120 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- D. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single MANUFACTURER, insofar as possible, and shall consist of equipment models which are currently in production.
- E. The equipment furnished shall be designed to operate satisfactorily between 0 degrees C and 40 degrees C for indoor panels and 50 degrees C for outdoor panels at up to 95 percent Relative Humidity (non condensing).
- F. Except where specifically noted otherwise, all outdoor panels and enclosures containing electronic or electrical components shall be equipped with sunshields on both sides, the front, the back and the top with a minimum separation of one

inch and a maximum separation of one and one-half inches. Sun shields shall be 14 gauge Stainless Steel or 12 gauge Anodized Aluminum or thicker. Finish with reflective white, two part epoxy coating or reflective, white, polyester powder deposited coating.

- G. All outdoor control panels and enclosures shall be equipped with 3 ½” stainless steel mounting uni-struts across the width of the back. For free-standing panels the struts shall be located half-way up the panel and six inches from the top. For other panels they shall be located 3” from the top and 3” from the bottom.
- H. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 volts-amperes (VA), unless specifically noted otherwise.
- I. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.
- J. All discrete inputs entering the panel shall be wetted by 120 VAC. Provide isolation relays if necessary to accommodate this requirement.
- K. All discrete output signals shall be equipped with interposing relays to electrically isolate them from the control system I/O.

2.02. LIGHTNING/SURGE SUPPRESSION

- A. Surge suppressors and arrestors meeting the requirements of ANSI Standard C-62.41 (latest revision) shall be provided as further detailed below.
- B. DC Signals. Lightning and surge protection shall be provided on all DC signal wires entering or leaving the panel. The protectors shall meet the following criteria:
 - 1. 35 mm DIN rail mounted with spring terminals.
 - 2. Response time of less than one nanosecond.
 - 3. Operating signal current: up to 0.5 A
 - 4. Capable of withstanding 5,000 Amps at IEEE/ANSI C-62.41 8 x 20 microseconds combination wave.
 - 5. Nominal series resistance of less than 2 ohms each leg
 - 6. Manufacturer/model:
 - a) Dehn DCO RK ME
 - b) Approved equal.

- C. AC Signals. Lightning and surge protectors for all incoming 120 VAC discrete signals lines shall meet the following criteria:
1. Serial protection.
 2. Nominal operating voltage: 120 VAC 47/63 Hz.
 3. Response time of less than 0.25 nanoseconds.
 4. Capable of withstanding up to 40,000 Amps at IEEE/ANSI C-62.41 8 x 20 microseconds combination wave.
 5. Manufacturer/model:
 - a) Phoenix Contact 2906840
 - b) Approved equal.
- D. AC Power. Lightning and surge protectors for AC power supply lines up to 15 Amps service shall meet the following criteria:
1. Serial protection with replaceable fuse.
 2. Failure indicator.
 3. Response time of less than five nanoseconds.
 4. Capable of withstanding up to 10,000 Amps at IEEE/ANSI C-62.41 8 by 20 microseconds combination wave.
 5. Manufacturer/model:
 - a) EDCO HSP121BT
 - b) Approved equal.
- E. Single phase AC Power (over 15Amps). Lightning and surge protectors for AC power supply lines over 15 Amps service shall meet the following criteria:
1. Parallel protection using MOVs and thermal fusing technology.
 2. Failure indicator
 3. Response time of less than five nanoseconds.
 4. Capable of withstanding up to 6,500 Amps at IEEE/ANSI C-62.41 8 x 20 microseconds combination wave.
 5. Manufacturer/model:

- a) EDCO FAS-120AC
- b) Approved equal.

2.03. CONTROL PANELS AND ENCLOSURES

A. Finish:

- 1. All front panel openings for panel-mounted equipment shall be cut with counter-boring and provided with trim strips as required to give a neat finished appearance.
- 2. With the exception of stainless steel panels, all steel panel surfaces shall be treated with phosphatized treatment inside and out, and then finished on the exterior with two coats of baked enamel of the approved color. Interiors of panels shall be white, ANSI No. 51.
- 3. Stainless steel panels shall be No. 7 polished, 316 stainless steel.

B. Doors:

- 1. All control panels shall have a continuous piano hinge door for ease of access. A minimum of 80% of the panel interior shall be exposed by doors.
- 2. NEMA 4X rated panel door openings shall be sealed and fully gasketed.
- 3. The inside of each door shall be equipped with a print pocket. Provide individually laminated 11x17 sheets for all wiring diagrams.
- 4. Two-door enclosures shall have a removable center post.
- 5. Sealed panel doors shall be equipped with quick-release latches.
- 6. NEMA 1 rated panel doors shall be equipped with a three-point latching mechanism.
- 7. Where noted or shown on the drawings, doors shall be equipped with a fully gasketed glass window to allow viewing of internally mounted devices without opening the door.

C. All components and terminals shall be accessible without removing other components except for covers.

D. All conduit entry shall be from the bottom only.

E. No components shall be mounted on the interior sides of any panel.

F. All panels shall be provided with an isolated copper grounding bus to ground all signal shield connections.

- G. Control Panels containing PICS control system equipment shall each be equipped with an internal, hand-switch controlled, LED light and 120V, 15 amp, duplex utility receptacle.
- H. All panels shall be provided with laminated as built electrical wiring diagrams in each panel.
- I. Nameplates:
 - 1. All front-face panel mounted controls and indicators shall be equipped with 10-year outdoor-rated adhesive laminated plastic nameplates to completely define their use. Provide Brady Type BBP31 or BBP33 as applicable or approved equal.
 - 2. All internal components shall be equipped with identification tags
 - 3. Each wire shall be uniquely identified and shall be labeled.
- J. Power Supplies.
 - 1. Uninterruptible power supplies (UPS) shall be provided in all control panels as follows:
 - a) Size the supplies for all internal equipment plus an additional 20% spare capacity.
 - b) Provide 15 minutes battery back-up capability at full load.
 - c) Provide relay option card for indication of “On UPS Power” and “Low Battery Level”.
 - d) For outdoor panels provide an UPS and battery rated for operation at up to 50 degrees C.
- K. Provide two diode-auctioneered DC power supplies for analog signal use.
 - 1. Provide individually fused DC power for field transmitters.
- L. Electrical:
 - 1. Main circuit breaker and branch circuit breaker for each branch circuit as required to distribute power from the main power feed.
 - 2. All breakers accessible when the panel door is open.
 - 3. No more than 20 devices on any single circuit.
 - 4. No more than 12 amps for any branch circuit.

5. Panel (or site) lighting, receptacles, heaters, controls, telemetry and fans on separate branch circuits.

M. Wiring:

1. Power wiring shall be 300 volt, type MTW tinned copper, No. 14 AWG size, for 120V service.
2. Discrete wiring shall be 300-volt type MTW tinned copper, sized for the current carried, but not smaller than No. 16 AWG.
3. Analog signal wiring shall be 300 volt, stranded copper in twisted shield pairs, no smaller than No. 16 AWG.
4. Panel wiring shall be routed within wire troughs or panduits.
5. Hinge wiring shall be secured at each end with the bend portion protected by a plastic sleeve.
6. Analog or dc wiring shall be separated from any ac power or control wiring by at least six inches.
7. Terminal blocks shall be provided for all field wiring entering the panel. The greater of 4 or 15% spare terminal blocks shall be provided.
8. No more than one wire per screw and yoke termination.

N. Construction:

1. Minimum metal thickness: 14-gauge.
2. Stiffeners as required to prevent deflection under instrument loading and permit lifting without racking or distortion.
3. When required, removable lifting rings and fill plugs to replace rings after installation.

O. Miscellaneous Equipment:

1. All panels shall be protected from internal corrosion by the use of corrosion – inhibiting vapor capsules, Northern Instruments Model Zerust VC, Hoffman, model A-HCI, or equal.
2. All sealed panels shall be equipped with combination drain/breathers, Crouse-Hinds model ECD18; or equal.
3. When noted on drawings, panels shall be equipped with thermostatically controlled space heaters to maintain internal temperatures above dew point.

P. All panels shall be manufactured items, Hoffman Engineering, or equal.

2.04. FRONT PANEL DEVICES

A. Potentiometer. Units shall meet the following:

1. Three-terminal potentiometers with a total resistance of 1000 ohms and a power dissipation rating of 2 watts
2. Oil-tight construction, rated NEMA 13
3. Resolution of 1 percent, and linearity of plus or minus 5 percent.
4. Panel mounting accommodating panel thickness between 1/16 to ¼ inch.
5. Legend plates with marking as noted.
6. Allen-Bradley, type 800T, or equal.

B. Selector Switch. Units shall meet the following:

1. Heavy-duty, oil-tight, industrial type selector switches rated for NEMA 4 service.
2. Contacts rated for 120-volt ac service at 10 amperes continuous.
3. Number of positions and contact arrangements as required.
4. Factory-engraved legend plate indicating position definition.
5. Panel mounting accommodating panel thickness between 1/16 to ¼ inch.
6. Black knob type operator.
7. Square D Class 9001, Type K; Allen-Bradley type 800T, or equal.

C. Pushbutton. Units shall meet the following:

1. Heavy-duty, oil-tight, industrial type push buttons rated for NEMA 4 service.
2. Contacts rated for 120-volt ac service at 10 amperes continuous.
3. Number of positions and contact arrangements as required.
4. Factory-engraved legend plate indicating function.
5. Panel mounting accommodating panel thickness between 1/16 to ¼ inch.

6. Operator: Red extended head for STOP, green flush head for START, black flush head for other functions.

7. Square D Class 9001, Type K; Allen-Bradley type 800T, or equal.

D. Indicating Light. Units shall meet the following:

1. Heavy-duty, oil-tight, push-to-test industrial type with integral transformer for 120V AC application.

2. Rated for NEMA 4 service.

3. Screwed on flat-faced lenses in colors shown on the drawings.

4. Factory-engraved legend plates.

5. Square D type K, Allen-Bradley Type 800T, or approved equal.

2.05. INTERNAL PANEL COMPONENTS

A. Control/Interposing Relays: All relays shall meet the following:

1. Compact, general-purpose, plug-in type.

2. Socket mounted.

3. Contacts rated for not less than 10 amperes at 120V.

4. Equipped with neon status lights and test buttons.

5. Permanent, legible identification

6. Potter & Brumfield series KRPA or approved equal.

B. Time Delay Relay. Time delay relays shall meet the following:

1. Available functions: On delay, Off delay, or one shot.

2. Socket mounted.

3. Knob adjustment.

4. Contacts rated for not less than 10 amperes at 120V.

5. Timing range as appropriate for the application.

6. Magnecraft series W211 or approved equal.

C. Terminal Blocks. Terminal blocks shall meet the following requirements:

1. Terminals capable of accepting 10-26 AWG wire.
2. DIN-rail mounting.
3. Connectors shall be either copper or steel. Use of aluminum connectors shall not be permitted without prior approval of the Engineer
4. Phoenix Contact or approved equal.

2.06. SPARES AND EXPENDABLES

- A. Provide the following spare parts:
 1. One spare d.c. power supply of each type provided.
 2. Five (5) spare relays of each type provided.
 3. Two (2) spare surge suppressors of each type provided
- B. Provide the following expendables:
 1. Ten (10) spare fuses of each type and rating supplied.

PART 3 - EXECUTION

3.01. INSTALLATION

- A. Control Panels shall be installed at the locations indicated on the Contract Drawings.
- B. Control panels shall be provided to the mechanical subcontractor for installation.
- C. Verify the correct installation of all panels supplied under this Specification Section.

END OF SECTION

SECTION 40 95 25

PROCESS INSTRUMENTATION AND CONTROL SYSTEM

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01. SCOPE OF WORK

- A. This Specification Section covers work related to the Programmable Logic Controllers (PLCs) that interface Process and Instrument and Control System (PICS) with process equipment.
- B. The work specified herein shall be furnished by the same SYSTEM SUPPLIER furnishing services and equipment as defined in 40 90 10.

1.02. RELATED WORK

- A. Related work specified elsewhere includes:
 - 1. Specification Section 40 90 00 defines work associated with the overall PICS.
 - 2. The PLCs will be mounted in control panels under Specification Section 40 90 15.

1.03. SUBMITTALS

- A. Provide the following submittals specific to the work defined herein:
- B. A PLC hardware shop drawing package that includes the following:
 - 1. Block Diagram: A detailed system block diagram showing all major components. Identify components by model number. Show interconnecting cables diagrammatically (by type and size).
 - 2. Bill of Materials: A list of all components, including all software. Group components by type and include component model number and part number, component description, quantity supplied, and reference to component catalog information.
 - 3. Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements. Clearly mark all options and features proposed for this project.
 - 4. Installation Details. Equipment installation drawings showing external dimensions, enclosure material and spacing, mounting connections, and installation requirements.

PART 2 - PRODUCTS

2.01. GENERAL REQUIREMENTS

- A. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single MANUFACTURER, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion through the installation of plug-in circuit cards or additional cabinets.
- B. The equipment furnished shall be designed to operate satisfactorily between 0 degrees C and 40 degrees C at up to 95 percent Relative Humidity (non-condensing).
- C. All equipment furnished shall be designed and constructed so that in the event of power interruption, or temperatures outside the operational range, the equipment specified hereunder shall go through an orderly shutdown with no loss of memory, and resume normal operation without manual resetting when power is restored.

2.02. PROGRAMMABLE LOGIC CONTROLLER

- A. All PLC equipment shall be based on the use of Allen Bradley's CompactLogix series. No other PLC series will be considered. All PLC modules shall be DIN-rail mounted within the Process Control Panel. Modules shall be selected from the following list:
 - 1. CPU Module. Module shall meet the following requirements:
 - a) Built-in dual Ethernet/IP ports and USB port for programming.
 - b) Support for up to 16 local I/O modules
 - c) 1 GB memory card.
 - d) 2 MB user memory.
 - e) Provide Allen Bradley 1769-L33ER.
 - 2. Power Supply Module. Module shall meet the following requirements:
 - a) Power requirement: 85-265 VAC.
 - b) Provide Allen Bradley 1769-PA2 or 1769-PA4 as necessary based on load requirements.
 - 3. Input/Output Modules. Furnish input/output modules sufficient to accommodate the inputs/outputs shown on the Contract Drawings plus an

additional 15% spares of each type. The spares shall be supplied fully wired such that it is only necessary to add field wiring and update the PLC database in order to activate them.

4. Discrete Input Module. Module shall meet the following requirements:
 - a) Sixteen 120 VAC inputs.
 - b) Provide Allen Bradley 1769-IA16.
5. Discrete Output Module. Module shall meet the following requirements:
 - a) Eight individually isolated contact outputs.
 - b) Operating AC voltage: 5-265 VAC.
 - c) Operating DC voltage: 5-125 VDC.
 - d) Provide Allen Bradley 1769-OA8I.
6. Analog Input Module. Module shall meet the following requirements:
 - a) Eight single-ended or differential 4-20 mA inputs.
 - b) Provide Allen Bradley 1769-IF8.
7. Analog Output Module. Module shall meet the following requirements:
 - a) Four individually isolated differential 4-20 mA outputs.
 - b) Provide Allen Bradley 1769-OF4CI.
- B. PLC Software. The latest revision of the programming software shall be installed as of substantial completion. Provide Rockwell Automation RSLogix 5000 Full Edition. Catalog No. 9342-RLD600ENE.
- C. Ethernet Switch. The switch shall be an industrialized, hardened metal DIN-rail mountable enclosure meeting the following requirements:
 1. Sufficient RJ-45 10/100 Base TX copper and fiber optic ports to support all necessary connections together with at least one spare copper port.
 2. Operating Temperature: Up to 80 degrees C.
 3. Power Supply – Dual redundant 10-49 Volts DC inputs.
 4. Surge protection on all ports and power inputs.
 5. Manufacturer/model:

- a) N-Tron.
 - b) Approved equal.
- D. Operator Interface Terminal. (OIT). The OIT shall be front panel mounted and meet the following requirements:
 - 1. 15 inch, full color touch screen graphical display.
 - 2. Power Requirement: 120 VAC.
 - 3. Ethernet and RS-232 communications ports.
 - 4. Windows CE operating system.
 - 5. FactoryTalk View Machine Edition Station application software.
 - 6. Provide Allen Bradley Panelview 7 model.

2.03. SPARES AND EXPENDABLES

- A. Provide the following spare parts:
 - 1. One of each PLC module including CPU.

PART 3 - EXECUTION

3.01. INSTALLATION

- A. Review and, if necessary revise or expand the I/O shown on the Contract Drawings to add the PLC addresses and verify completeness of the listings.

3.02. TRAINING

- A. Hardware Maintenance: Provide a minimum of two days of hardware training for up to three of the OWNER's personnel in the maintenance of the PLC hardware which shall include:
 - 1. Training in standard hardware maintenance for the equipment provided.
 - 2. Specific training for the actual hardware configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up.
 - 3. Test, adjustment, and calibration procedures.
 - 4. Troubleshooting and diagnosis.
 - 5. Component removal and replacement.

- 6. Periodic maintenance.
- B. Software Maintenance: Provide a minimum of two days of software training for up to four of the OWNER's personnel in the maintenance and use of the PLC software.

END OF SECTION

SECTION 40 90 26

PROCESS INSTRUMENTATION AND CONTROL SYSTEM

PLC PROGRAMMING

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This Specification Section covers work related to programming the PLC furnished under Specification Section 40 90 25.
- B. The Work specified herein shall be performed by the SYSTEM SUPPLIER defined in Specification Section 40 90 00.

1.02 RELATED WORK

- A. Specification Section 40 90 00: General Requirements.
- B. Specification Section 40 90 25 defines requirements applicable to the equipment to be programmed hereunder.

1.03 SUBMITTALS

- A. Provide an application programming design package that illustrates each individual control strategy using a program flow chart or written description. The descriptions shall also include details of all formulae to be used (e.g. chemical feed, flow paced, etc.). This submittal shall be Approved or Approved As Noted prior to any PLC programming Work. Simply repeating the descriptions provided herein shall not be acceptable.
- B. Provide a final documentation package that includes:
 - 1. Licenses in the Owner's name for PLC and, where applicable, OIT programming software.
 - 2. Final copies of all programming files on USB flash drive.
 - 3. A complete printout of all "Annotated" PLC program logic.

PART 2 - PRODUCTS (SECTION NOT USED)

PART 3 - EXECUTION

3.01 PLC PROGRAMMING – GENERAL MONITORING

- A. Provide the following general monitoring functions for analog inputs:

1. For all analog inputs:
 - a) Provide out of range alarms if the input signal goes outside the instrument's range
 - b) Provide individually operator adjustable emergency high and low alarms when the value goes outside the allowable process range.
 - c) Provide individually operator adjustable high and low alarms when the value goes outside the normal process operating range.
 - d) Provide a dead-band on all alarm settings.
 - e) 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 5-minute average 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.
 4. For all analysis analog inputs:
 - a) Monitor for and record minimum and maximum daily values. Record the date and time of occurrence for each.
 - b) Calculate a running daily average reading. At midnight, transfer the value to yesterday's average and restart the averaging.
- B. Provide the following general monitoring functions for discrete inputs:
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 whenever an un-commanded change of state occurs

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 via the HMI.
 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.
- C. Special Level Monitoring. Based on the level and tank dimensions, continuously calculate the volume of liquid in each storage tank and display on the associated graphic screen.

3.02 PLC PROGRAMMING – GENERAL CONTROL

- A. General Requirements applicable to the control strategies are:
1. All software fault conditions that are set can only be cleared by operator acknowledgement.
 2. Wherever in the descriptions the control strategy refers to the operator, it is intended to mean via the Operator Interface Terminal (OIT) or HMI process graphics.
 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 OIT software for this purpose.

4. The control functions described herein are not intended to be complete comprehensive programming logic descriptions. They describe 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. Common Constant Speed Motor Operator Control. For all constant speed equipment, provide an operator controllable software HAND/OFF/AUTO switch and proceed as follows:
1. While the switch is in HAND run the equipment.
 2. While the switch is in OFF, stop the equipment and prevent any start commands.
 3. While the switch is in AUTO, take start and stop signals from the appropriate automatic control strategy defined herein.
- C. Common Variable Speed Motor Operator Control. For all variable speed equipment, provide an operator controllable software HAND/OFF/AUTO switch and SPEED potentiometer and proceed as follows:
1. While the switch is in HAND run the equipment at the speed set by the potentiometer.
 2. While the switch is in OFF, stop the equipment and prevent any start commands.
 3. While the switch is in AUTO, take start, stop, and speed signals from the appropriate automatic control strategy defined herein.
- D. Common Motorized Valve Operator Control. For all valves, provide an operator controllable software OPEN/CLOSE/AUTO switch and POSITION potentiometer where applicable. Proceed as follows:
1. While the switch is in OPEN, open the valve to the position set by the potentiometer.
 2. While the switch is in CLOSE, close the valve and prevent any other commands.

3. While the switch is in AUTO, take open, close and position signals from the appropriate automatic control strategy defined herein.
- E. Common Motorized Equipment Flow Monitoring. For all motorized equipment provided with a dedicated discharge flow meter, issue an alarm and stop the equipment if the flow fails to reach an operator controllable minimum value within an operator adjustable time of being called to start.

3.03 SPECIFIC PLC CONTROL STRATEGIES

- A. Fill Valve Control. There are two fill valves; the NORMAL FILL valve (henceforth herein referred to as V-1) is a solenoid enabled altitude valve and the FAST FILL valve (henceforth herein referred to as V-2) is a motorized valve. Provide an operator adjustable time-of-day setting for the NORMAL FILL mode. Provide operator controllable enable and disable pushbuttons to override the NORMAL FILL timer. Disable all Low Pressure pumping whenever either fill valve is open. Proceed as follows:
1. Provide the following operator adjustable GST levels listed in order from highest to lowest:
 - a) LSH – Close Fill Valves.
 - b) LSL1 – Enable Normal Fill Valve.
 - c) LSL2 – Open Fast Fill Valve.
 2. While the station is in NORMAL FILL mode, enable and disable valve V-1 based on LSL1 and LSH.
 3. If the level falls to LSL2, open the FAST FILL valve until the level reaches LSH.
- B. High Pressure Pumping Control Strategy. Establish an automatic LEAD/LAG assignment for the fire pumps Nos. 1 and 2). Automatically rotate assignments each time both pumps stop. Allow the operator to override this and manually assign the pumps. Proceed as follows
1. Provide the following operator adjustable software functions:
 - a) PSHH – Upper operating limit for distribution pressure.
 - b) PSH – Upper deadband limit for distribution pressure.
 - c) PS – Desired operating value for distribution pressure.
 - d) PSL – Lower deadband limit for distribution pressure.

- e) PSL – Lower operating limit for distribution pressure.
2. Stage the pumps in accordance with the following:
 - a) Stage 1 – Jockey Pump (No. 3) ON.
 - b) Stage 2 – Swing Pump (No.4) ON, Jockey Pump OFF.
 - c) Stage 3 – Swing Pump and Jockey Pump ON.
 - d) Stage 4 – LEAD Fire Pump ON, Swing Pump and Jockey Pump OFF.
 - e) Stage 5 – LEAD Fire Pump and Swing Pump ON, Jockey Pump OFF.
 3. Provide a PID control loop that adjusts pump speed to maintain PS.
 4. Suspend the PID when the pressure reaches PS.
 5. If pressure rises above PSH, run the PID until the pressure starts to fall then freeze the PID and maintain current speed.
 6. If pressure falls below PSl, run the PID until the pressure starts to rise then freeze the PID and maintain current speed.
 7. Call for the next stage if the speed signal is at an operator adjustable maximum and the distribution pressure falls to PSL for an operator adjustable time.
 8. Reduce to the next lower stage if the speed signal is at an operator adjustable minimum and the distribution pressure rises to PSHH for an operator adjustable time.
 9. When a pump is to be started, temporarily suspend the PID loop and set the currently running pump(s) speed to an operator adjustable value. Once the starting pump reaches the speed of the running pump(s), restart the PID.
 10. Prevent a pump starting within a preset time of it being turned off.
 11. If a pump is called and fails to start or fails while running, automatically go to the next stage.
 12. If the LEAD fire pump is called and fails to start or fails while running, automatically call for LAG fire pump.

- C. Low Pressure Pumping Control Strategy. Establish an automatic LEAD/LAG1/STANDBY assignment for the pumps. Automatically rotate assignments every 24 hours at midnight. Allow the operator to override this and manually assign the pumps. Proceed as follows
1. Provide the following operator adjustable software functions:
 - a) PSHH – Upper operating limit for distribution pressure.
 - b) PSH – Upper deadband limit for distribution pressure.
 - c) PS – Desired operating value for distribution pressure.
 - d) PSL – Lower deadband limit for distribution pressure.
 - e) PSLI – Lower operating limit for distribution pressure.
 2. Provide a PID control loop that adjusts pump speed to maintain PS.
 3. Suspend the PID when the pressure reaches PS.
 4. If pressure rises above PSH, run the PID until the pressure starts to fall then freeze the PID and maintain current speed.
 5. If pressure falls below PSL, run the PID until the pressure starts to rise then freeze the PID and maintain current speed.
 6. Call for another pump if the speed signal is at an operator adjustable maximum and the distribution pressure falls to PSLI for an operator adjustable time.
 7. Stop the longest running pump if the speed signal is at an operator adjustable minimum and the distribution pressure rises to PSHH for an operator adjustable time.
 8. When a pump is to be started, temporarily suspend the PID loop and ramp the currently running pump(s) speed to an operator adjustable value. Once the starting pump reaches the speed of the running pump(s), restart the PID.
 9. Prevent a pump starting within a preset time of it being turned off.
 10. If a pump is called and fails to start or fails while running, automatically call for the next pump.

3.04 PROGRAMMING ACCEPTANCE

- A. Regardless of any submittal approvals, final acceptance of the system programming will occur during the final Demonstration Test.
- B. The ENGINEER/OWNER reserves the right to require minor changes in the graphics and programming during the test.

END OF SECTION

SECTION 40 90 30

REMOTE TELEMETRY UNIT

PART 1 - GENERAL

1.01. SCOPE OF WORK

- A. This Specification Section defines requirements for a Remote Telemetry Unit (RTU) through which the site shall be monitored by the Owner's existing Supervisory Control and Data Acquisition (SCADA) system.
- B. For consistency with the Owner's SCADA system the RTU shall be furnished by Mission Communications, Norcross, GA, henceforth referred to as the RTU SUPPLIER, and no equal.
- C. The RTU SUPPLIER shall furnish the RTU to the SYSTEM SUPPLIER IN 40 90 00 .
- D. The SYSTEM SUPPLIER shall furnish all miscellaneous accoutrements (e.g. antenna, antenna lead-in cable and lead-in cable surge suppressor) necessary to provide a fully operational RTU installation.
- E. The SYSTEM SUPPLIER shall complete the RTU Installation Form furnished with the RTU and submit it to the RTU SUPPLIER in order to register the RTU and make it fully operational.

1.02. SUBMITTALS

- A. Furnish, as prescribed under the General Requirements, all required submittals covering the items included under this section and its associated sections of the work.
- B. Submit complete, neat, orderly, and indexed submittal packages. Handwritten diagrams are not acceptable and all documentation submittals shall be made using CADD generated utilities as specified herein.
- C. Partial submittals or submittals that do not contain sufficient information for complete review or are unclear will not be reviewed and will be returned by the ENGINEER as not approved.
- D. Provide all shop-drawing submittals on a USB flash drive in PDF format.
- E. Provide a single RTU shop drawing submittal that includes the following:
 - 1 Data sheets and technical specifications defining the specific model for the RTU and all accessories.

2 Installation details for all components.

1.03. STANDARDS

- A. 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.
- B. Any equipment that does not have a UL, FM CSA, or other approved 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 Electric Code and OSHA requirements.
- C. Any additional work needed resulting from any deviation from codes or local requirements shall be at no additional cost to the OWNER

PART 2 - PRODUCTS

2.01. REMOTE TELEMETRY UNIT (RTU)

- A. The RTU shall incorporate a radio that utilizes the data side of any cellular system to transmit the data and alarms monitored.
- B. Microprocessor features like data transmission rates shall be able to be adjusted through the cellular system without any site visits necessary.
- C. RTU shall have eight (8) digital inputs. These eight (8) inputs must have end of line resistor supervision, or similar supervision, that can detect normal alarm trip inputs and detect input wiring disconnection/shorting as a distinctly different signal and report. The digital inputs shall be user selectable as normally open (NO) or normally closed (NC). Electrical drawing E-06 defines the signals to be connected to these inputs.
- D. The RTU shall have built-in alarms for input wiring fault, AC failure, communication failure and low battery level detection.
- E. The RTU shall be powered by 120 volts AC and have a built in battery backup capable of keeping the RTU powered for 30 hours in case of primary AC failure.
- F. The RTU shall utilize a transmission scheme that encrypts the transmitted data utilizing a 128 bit encryption method that meets or exceeds the advanced encryption standard (AES). The 128 bit AES encryption shall be at all stages of data transfer and storage
- G. The cellular radios shall all have private IP addresses

- H. All alarms regardless of unit type will be transmitted immediately upon occurrence; delays can be added by the customer at the RTU or the supplier's website.
- I. The RTU shall continuously transmit all digital state changes on an as occurs basis; analog values shall be transmitted at least once every two minutes.
- J. The RTU will have an effective, continuous, transfer rate of at least 19,200 baud.
- K. The RTU enclosure shall be NEMA 12 steel and wall-mounted in the Electrical Building.
- L. The RTU shall be Mission MyDro 850, no equal.

2.02. RTU I/O EXPANSION

- A. The base unit inputs and outputs are shown in the Contract Drawings.
- B. Where additional digital inputs are required at a particular site, furnish the RTU with an optional, eight input expansion option module connected to the base RTU via RS-485. Provide Mission model OP653, no equal.

2.03. ACCESSORIES

- A. The Contractor shall furnish miscellaneous accessories necessary to implement the connection of the RTU to the cellular phone network as further defined below.
- B. A cellular phone whip antenna rack mounted adjacent to the RTU using stainless steel hardware.
- C. Antenna cable surge protector, bulkhead mounted on the bottom of the RTU.
- D. Antenna lead-in coaxial cable connecting the antenna to the surge protector and the surge protector to the RTU.

PART 3 - EXECUTION

3.01. INSTALLATION

- A. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance.
- B. Weatherproof all antenna cable connections using butyl rubber tape.

3.02. DEMONSTRATION TEST

- A. Upon completion of installation and set-up, demonstrate that the RTU data is displayed at the Owner's master SCADA location.

- B. Simulate status changes at the RTU and demonstrate they are correctly reported and alarmed.

END OF SECTION